



Transcript

Occurrence of natural and anthropogenic (man-made) hexavalent chromium (CrIV) near a mapped plume

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Dr. John Izbicki, USGS Research Hydrologist: But first, I was asked at the -- as we were winding down the sampling, by Ian Webster, to come out here and give a presentation to the community on the work that we did. And I looked at Ian, and I said, well, you know, we're just going to be having completed the field work for one week.

I'm not going to have any results back.

I'm not going to have anything to say to the community.

And he encouraged me to say, well, just come on out anyway and give a talk.

Everybody's interested.

So I have 30 slides for you, so I guess I have more to say than what I thought I would.

And, you know, if you get bored or whatever, you can head out through the door.

But the first four slides are slides that you've seen before.

I was up here in the summer when I gave a presentation on the proposal that we had and what had been approved by the Regional Water Quality Control Board and what was in the contractual arrangements between the U.S. Geological Survey and the State of California.

This slide you've seen before with one exception.

I've changed the title from the proposal to study the occurrence to now we're actually in it.

And so we're looking at the occurrence of natural and anthropogenic -- manmade -- chromium VI near a mapped plume.

And I want to thank everybody on the CAC and everybody on the TWG who really hard to make this happen.

And that proposal is online.

It's right there if you should want to try and look at it.

But at this point, all you see the words on slides and images.

And now I'll actually show you some pictures.

I don't have a lot of data back yet, but I do have some things that I can show you.

And I do want to point out that we're really under contract with the Lahontan Regional Water Quality Control Board, not with PG&E.



So we are an independent arbitrator of the data.

What we collect, I will interpret with my best scientific ability to be as unbiased as possible.

And so I don't know what the answer is.

I don't know if that 3.1 current background level will increase, decrease, will be different in different parts of the study area.

And that's why we're doing the study, so that we can find out and so that we know and answer that as accurately as I can.

But along the way, I have guidance.

And I have guidance from the community, and I have guidance from technical experts at PG&E who are well qualified [inaudible] and guidance from technical experts at the Regional Water Quality Control Board.

And the goal is to produce answers for the community but also produce answers that can be worked with in a very reasonable fashion by both the regulatory groups that are involved in this and the people who are being responsible for cleaning up the plume.

Go ahead and advance this.

Again, you've seen this slide before.

Here's the study area.

Here's the Mojave River.

Here's the mapped plume.

[Ridell] went through just changes in that plume extent.

Previously, you can see the northern extent.

You can see the southwestern extent.

The Mojave River here.

The Lahontan [inaudible] compressor station is located about there.

And for purposes of discussion within the TWG, we've divided this into a northern area, a western area, and an eastern area.

And you can see the map back there that shows that to you a little bit more clearly.

But the study has a very prescribed purpose, and that is to evaluate the occurrence of both natural and anthropogenic, which is manmade, chromium VI that would be released from the compressor station between 1952 and 1964 and how it's moved within the groundwater system.

And we will ultimately estimate background chromium VI concentration both upgradient, in this area, downgradient, here, and in margins of the plume boundary.

And those numbers will be used for regulatory purposes by the Lahontan Regional Water Quality Control Board and by PG&E as part of their clean-up activities.

The issues are complex, and they've been plaguing the community for decades -- you know, for a long number of time, but they're not unknowable.

I think that if we measure the right things, we measure them the right way, we can come up with answers that will -- everybody can agree upon at least the nature of those answers.

Whether or not you agree upon the nature of the remediation activities or how those answers translate themselves into actual activities is discussions that I'm not really part of.

The United States Geological Survey is not a regulatory agency.

We are solely a scientific agency.



We don't have management responsibilities.

So again, my job here is to just produce the best possible science that I can for the community and for everybody who is a stakeholder.

And again, to produce usable, understandable, unbiased, and actionable information for the community.

There are additional purposes here, and there's been a lot of concern in the community about trace element concentrations other than chromium VI.

That would include manganese, arsenic, uranium.

We've recently come out with a USGS publication that will be online very soon.

I have to just put some images and photos, basin-wide, in the Mojave groundwater basin and the Morongo basin, on the back table there.

So there's about 12 years' worth of data that you can go ahead and look at.

And take a look for yourself what's out there and how concentrations vary regionally.

We work very, very closely with this community, Project Navigator, the Regional Water Quality Control Board, and the consultants.

And the idea is to make this study as effective and broad-ranged as we can within the purpose of the goal that we have stated for us.

Because we'll learn a lot of other things about the basin, about the water, and about the groundwater quality other than just the occurrence of chromium VI.

Go ahead and advance again.

The study was divided into eight major tasks.

I listed them here.

My primary goal was the contract was signed towards the end of January was to breathe life into all these tasks as rapidly as possible.

[Ridell] mentioned that we were out here in mid-February discussing the project and how to get it started.

And we were out within six weeks of signing the contract collecting samples.

We're here now within about 10 weeks of signing the contract presenting to you at least some preliminary -- not data, but at least what we did and why we did what we did to move as quickly as we could on what is task three, sample collection and analysis of water, and was task two, sample collection and analysis of rock and alluvium.

This looks like some pretty complex ideas here, but in reality, this was a very easy proposal to write and scope.

And the reason is that it was the members of the community that really had the ideas.

They came to me with questions, and they wanted to know answers to these questions.

One of the questions that drove a lot of their thinking was, we're being told that there's naturally occurring chromium VI out in the Hinkley Valley?

We want to see.

We want to see numbers [on that].

We want to see if that's really an accurate statement or not.

We're being told that groundwater moves.

The Mojave River to the north, in this direction, and they could see the maps.

They could understand what gradients mean, and they could understand how groundwater flows under present-day conditions.

But as a community, they've lived out here all their lives.



And they know that during the height of the agriculture [inaudible] in the 1950s and '60s, prior to the adjudication, things were different.

And they wanted to know.

Part of their questions were, how did things vary back in the past?

And is there a footprint of what might have occurred in the past that left -- that is left in the water today?

It might help us understand how things were moving through the system.

[Ridell] talked to you about remediation activities within the ground in the in-situ reductive zone that's being created by PG&E in order to reduce the chromium, and we've seen it's very effective.

But the community wanted to know, we're going to live here for the rest of our lives.

Our children are going to live here.

This is going to be decades for us -- maybe 50 years, [inaudible] years in the future.

Is this a permanent solution?

Can we look at that also and say something about that?

So that's why we have these very, very complex tasks.

But what drove them were just very simple, thoughtful questions by members of the community.

Task two -- we started working on this March 1st.

Roger had pictures of the core storage area within the PG&E garage building on [Sarah] Road and Community Boulevard.

And there's a lot of material there collected over probably 10 years or more worth of drilling.

I believe [Ridell] mentioned a number of 500 or so wells that were installed by PG&E.

Much of that material is preserved, and we can look at that.

This is the instrument that we're using.

That's an X-ray fluorescence device.

And it's a handheld instrument.

It's probably a very fore-cousin of the laboratory-grade instrument that has -- if I get this number right, it's got a 4-watt lamp in there that produces X-rays.

A laboratory instrument would have about 4,000-watt lamp within it.

So obviously a much more powerful piece of equipment, but this is extremely versatile and extremely for good for us.

We had to get that instrument.

We had to learn how to use it and get it out in the field real quick.

One of the things you have to do when you're doing science is you have to demonstrate that you know what you're measuring and that what you're measuring is accurate.

To do that, you use things called standards.

We had to obtain standards.

This one here is pure silica -- the white material [inaudible].

It has no chromium in it.

It has no -- none of the other trace elements that we're looking at.

This thing will produce information on 27 different trace elements.

The second one is the soil.

It's traceable to the National Institute of Standards.



Has a concentration of about 53 parts per million, milligrams per kilogram, of chromium in it.

And so we had to know, can we measure that?

Can we measure that accurately?

The other one is from the U.S. Geological Survey.

It comes from Hawaii.

It's a basalt.

It has a higher concentration, about 280 parts per million of chromium.

The average in the continental crust is about 230 parts per million chromium.

So these are kind of on the low-to-average end there.

And you can see just how well we do over time.

These are laboratory measurements here.

We did a lot of testing with that instrument.

How frequently do we have to measure an individual mass of material in order to get consistent numbers?

How does our instrument perform?

The silica blank -- these are actually less-than numbers, so they're in open circles.

That scale ranges from zero to 10.

The next scale ranges from zero to 100.

The next scale from zero to 1,000.

That's an increase by a factor of 10.

I refer to that as an order of magnitude, just so you get an idea, we're multiplying by 10 at a time.

There's the standard -- 53 parts per million.

Pretty close.

Little bit high, but very [inaudible].

Here's our basalt.

The standard is 280 parts per million.

Again, pretty close.

In this case, we're a little low.

So took us a while to figure out how to use the instrument in order to get these [inaudible], but we learned.

And that was the purpose of what we did with this prior to getting out in the field.

We had a little bit of time -- six weeks or so to work with it and figure out what we were doing and how to make measurements, make sure they're accurate.

Go ahead.

This is that core library, sitting here.

Quite a bit of material.

There's a core station.

Krishangi was -- came to for probably three weeks.

And I occasionally let her get out and see some rocks every now and then.

But during that three-week period, she made more than 800 measurements.

Probably at this point in time, she's probably got more than 1,000 measurements that she's made back in the office to add to this.



And I think it's going to be a really valuable tool in terms of producing quantitative information for us on what's in the rock and how that can get into the water as naturally occurring chromium VI.

Again, here's the instrument.

This is in the mode where we have a sample here.

You close that so the X-rays don't come out, and then you make your measurements.

Here it's being used, actually placed right on the basalt core material, and we're making a measurement there so that you can sort of see how that all works and how we collect that data.

And it takes time.

You know, 800 measurements and, you know, a minimum of, you know, five minutes -- three to five minutes sitting there with that instrument.

Then preparing the next sample, getting it out there, deciding what you're going to do -- probably what takes you the longest time is physically describing these materials.

You know, is it sand?

Is it silt?

Is it clay?

What does it look like?

Geologically, what is it composed of?

A lot of work involved there.

Go ahead and advance again.

This is what the output looks like.

This is actually material that's from the flood plain aquifer of the Mojave River.

And if I were a good -- had a good memory, I would remember what this was from.

Krishangi?

Krishangi Groover: NW 136.

Dr. Izbicki: NW 136, which is to the north, and I believe that's out along Mountain View Road, not quite all the way to Red Hill, but getting out there.

And again, the instrument sitting here.

It has a little camera on it.

This is very distinctive Mojave River flood plain material.

And I say that -- when you look at these, and I don't know if you can see it from the back, but those [grids] are rounded.

They have a lot of pink [inaudible] in them.

If you walk out there -- and I showed Roger this out in the field -- way out, all the way by Red Hill, look down on the ground, and you scoop up the sand that's there.

And it looks like that.

It's well-rounded.

It's got these pink [inaudible].

If you walk down to the Mojave River and scoop up the same handful of sand, hold them side-by-side, you can't tell the difference.

It's very clear that the Mojave River has extended north past Red Hill into our valley, and you can see it with your own eyes just by looking at it.



Here's the data that comes off here.

There's three channels that measure a variety of things.

Each one of these peaks represents an element that's in that rock.

And what happens, if you imagine an atom -- you have to think back now to high school -- and that atom had a bunch of electrons circling it.

You hit it with the X-rays, it excites the electrons, and they go from their inner positions on the inner shells to their outer positions on the outer shells.

And then they collapse.

But when they collapse, they emit X-ray radiation again, and that's called fluorescence, and that's what we measure.

Each element has a certain number of protons, which is what makes it an element.

And paired with that is the same number of electrons, which gives us that negative charge.

And it's different for every element.

So their electron configuration from every element is different.

And each one produces a unique pattern when in fluorescence, and that's what we measure.

That's how we can tell the 27 or so different elements that we measure using this particular instrument.

Had to do some fine-tuning.

We went back to the factory probably within a week of having it in order to make sure that it was actually working correctly and was precise and to tune it so that it was fine-tuned specifically for chromium, even though we're measuring a bunch of other elements.

Go ahead and advance again.

Community Member: Dr. Izbicki, now, that's total chromium, correct?

Not just . . .

Dr. Izbicki: That is total chromium, and that is total chromium in the rock.

So in general, it's probably chromium III, and that's much different than what's in the water.

What we're concerned about is chromium VI in the water, but this is a rock number.

And also, just take a look at those numbers.

Those are milligrams per kilogram.

So in the rock, when I'm talking about solid material, that's parts per million.

And the water, when I'm talking about what's dissolved in the water, that's parts per billion, typically.

And I want to make that point, and it'll actually come up a little bit later in the talk, so that's a good point to -- brought out.

Thank you very much.

And -- because people get scared sometimes when I -- I've noticed that when I'm talking about these rock numbers to the community groups.

And I start saying, you know, we've got 200 or so parts per million, and they think about what they're used to hearing about in the groundwater, and it's 3.1 parts per billion level.

And I apologize for scaring people.

It's a units issue, and rock is different than water.

This particular rock -- and we found this since we last spoke with the CAC.

Krishangi did some walking around up in the hills near [Wrightwood].



I had believed that it was there from the reading I had done but had never seen it.

You saw some green rocks [inaudible] when we brought it into the office there.

And that had about 2,000 parts per million, milligrams per kilogram of chromium.

This is fuchsite.

It's a chromium mica.

Here you see its picture close up here -- 8,600 parts per million of chromium.

That's over in the [Wrightwood] area, so that's not here.

That's a very, very high number.

A very, very chromium-rich [source] rock.

It's important for us to look at things like this elsewhere so that we understand the natural ranges that we're dealing with in the environment.

We don't see this rock -- we don't see this type of material in the hills that surround the Hinkley Valley.

Go ahead and advance again.

But primarily, although I think we could get some very good, valuable, interpretive information out of the X-ray fluorescence, it's primarily a screening tool.

And by that I mean we can make a lot of measurements really rapidly, really quickly.

And with that, we can make decisions on which materials we want to spend real money on for more expensive analyses.

And so of those 800 to 1,000 measurements that we have, we're going to select a fewer number of samples, and we'll send them off to places in Menlo Park -- people who are working with me, colleagues of mine in the geologic division in Denver.

And we'll put them on more complex instruments.

This is an instrument from a photograph that [Ridell] took over -- touring labs in Menlo Park.

It's a Raman spectrom -- spectrometer -- I can't say that word.

I apologize.

But, you know, that's the image of a mineral grain there.

That's its elemental composition.

And we'll look at things in greater detail than just the X-ray fluorescence device that we talked about here.

But it's a first step.

In three weeks, we have a lot of data.

I will spend a lot of time looking at that data over the next few months.

It's going to take a considerable amount of manpower and effort just to wade through that in order to understand what we have and then in order to make rational decisions about what we need to do more in-depth analysis on.

Go ahead and advance again.

Task three.

And task three did really just start the first week of March.

We had worked on task three with money that we had as part of the proposal development process for probably a year.

And the ultimate goal of that was to identify wells that we wanted to sample when we actually got out in the field.



There's a map up in the back there that has a pretty good illustration of the wells that we actually sampled. Initially, I thought we have -- in the project, enough money to do 90 samples with this very, very complete analytical suite that Roger was developing.

Initially, I thought, over the years of the project, we would do it in three phases -- 30, 30, and 30.

I had so many good suggestions from members of the community, from PG&E, and from the regulatory groups about wells that we should be sampling that we decided to do it in a group of 40, 30, and 20 -- sort of front-load the samples so that we'd have some -- answer some questions early on when this data started coming back.

One of the first things that we needed to do as far as this evaluation of existing data that was tasked on was how good was PG&E's data?

People in the community and the CAC had been looking at data, and they'd been looking at maps for years. But they really didn't know where it was coming from.

They didn't know -- they didn't have an idea of how much effort was being put forth into it and how good the labs were that were doing it.

So we spent a lot of time reviewing that data.

And these bars here are just kind of indicating variability in terms of a statistical phrase -- [inaudible], but the lower the bar, the better the analytical result.

We see PG&E actually made some changes in what they were doing between 2011 and 2012 and produced better data.

As a group, they're like everybody else.

They're always striving to do the best job they can, get the best data that they can.

And whatever decisions that were made at that point in time are actually pretty good ones.

They resulted in better data.

Actually, they changed labs is what they did.

And we can actually see here in terms of lab efficiency samples, how well those labs were performing on known water analyses.

Their variability went down.

You know, they did good.

They getting good data.

They're working as hard as they can to get the best numbers that they can possibly produce for you.

Like anybody else who does this, they compared chromium total to chromium VI.

They had a slight excess in these samples of chromium total compared to chromium VI, which is pretty normal.

All in all, what we saw was pretty high-quality data.

You can advance.

That made us comfortable to look at the data.

And the first thing we did was look at trends in the data.

This was all done collectively as part of the TWG between the USGS, between PG&E, between the Lahontan board, and the community.

And this map kind of summarizes it.

The red dots are [inaudible] showing trends in chromium VI concentrations.

Collectively, when we look at the data, I wanted to show you that it's not all bad news that's going on.

They all showed the plumes shrinking in different areas.



And these data reflect that, very much so.

36% of wells -- this is of 500-or-so-14 wells that they have out there that they sample and analyze -- the graph is showing that the trend is things are decreasing.

One would expect about 5% to do that by chance, so this is a pretty significant number statistically and pretty important for the community.

I was very interested in this 13% of the wells that showed upward trends.

Again, about 5% one would expect to show an upward trend just by chance.

So there were things going wrong, particularly in areas of the west where [Ridell] has already talked about.

And we focused on wells that had trends in our well selection.

Because I'd like to get those early in the study, and I'd also like to get those later in the study.

So if changes occur during the course of the study, we have this very complete suite of chemical and isotopic data to look at those changes and determine what they are.

Go ahead and advance again.

And ultimately, we came up with this list of monitoring wells that we would work with.

It's probably easier to see it back there.

It has never been fixed in time until the actual samples were collected.

As late as mid-February, the TWG was working on ensuring that everybody was satisfied with that list and that the wells that were to be sampled were in fact wells that everybody was comfortable with.

Go ahead and advance again.

And we've seen a picture very similar to this from Roger and Betty's field trip out in the field.

This is a staff member of mine, Greg Smith, working very closely with Blaine Tech people in sample collection out there.

And this was done by design and by intent.

They are PG&E's monitoring wells.

Those wells were put in for very specific regulatory requirements.

They have very specific legal implementations in terms of their data and how PG&E needs to respond to data that come from those wells.

I did not want to put my pumps and my equipment in those wells unless it was absolutely necessary to obtain data.

So in some cases, we actually did have to bring some of our specialized equipment out to collect some of these samples.

But I didn't want to see a change in the chromium VI concentration that may have occurred during our sampling period and have somebody come back and say, well, you put a pump in there that wasn't clean, or contaminated the well, or you did something.

So that's one of the reasons why we work very closely with them.

And the other reason is experience.

I mean, they do know the wells.

They know how these wells perform, which wells will produce a lot of water, which wells won't.

And I would like to take advantage of knowledge and experience whenever I have the opportunity to do so.

So by intent and design, we work very closely with PG&E and the consultants to collect these data.

We've seen this list before from Roger in his little slide show.



Here are the constituents that we were analyzing for field parameters.

PG&E does that also.

A lot list of chemical constituents in general.

When PG&E goes out on their quarterly sampling rounds to sample 500-or-so wells, they only have time and funding to send the chromium total and chromium VI.

And it would be -- it's a huge task to do that of 500 wells.

It would be almost completely infeasible for them to do more in the timeframe that they have available.

But for us, we have more time.

We're doing this as a very specific purpose.

As Roger said, it takes a long time to collect these samples.

It takes about three to four hours to collect one individual sample for a range of constituents for a range of purposes.

Some of them are for things that you readily understand -- chromium VI and chromium total, what are their concentrations.

Same thing with arsenic, manganese, uranium, and other constituents.

You understand why we would want to measure the chemistry of the water and how these relate to public health.

Some of these are much different.

Isotopes -- what an isotope is, is you imagine an atom again, has a certain number of protons.

That's what makes it a carbon atom.

That's what makes it a silicon atom.

That's what makes it a calcium atom.

But it may have fewer or more neutrons.

Those neutrons change its molecular mass.

That's called an isotope of an atom.

If it has a little bit different number of neutrons in there, it makes a very big difference and a very measurable difference in physical behavior of these constituents in groundwater and how they react with rock and how they come into solution.

We can measure that.

We can measure it for the water isotopes, where we look at oxygen-18 and deuterium, which are [hard] water molecules.

And we can tell where the water in the ground came from.

Virtually all the water that we have seen, based on work that I've done over 30 years in the Mojave Desert, and based on work that's been done by PG&E, kind of at our suggestion, has been sourced as recharged water from the Mojave River.

Almost exclusively, everything that's found comes from the Mojave River.

I know you're out here during the summertime.

You see rainstorms.

You see flow in these washes.

And it looks like a lot of water.

In mass, it's not.



It's that Mojave River.

Those flows that occur once every five to seven years, on average, that puts tens of thousands of acre-feet of water in the ground in very short periods that really comprises the bulk of the water that's in the system.

Traces of the age of the water.

We know that the releases from the compressor station occurred between 1952 and 1964.

And then we know that the big flows in the Mojave occurred in about 1968.

But that period of the release is a period that coincided with the atmospheric testing of nuclear weapons.

So there's lingering radiation in the environment from that, and it's preserved within the water samples, and we can measure that.

We can determine the age when that water went underground and if it's of the right time period to be associated with the releases from the compressor station.

We also look at industrial gases -- chlorofluorocarbons, sulfur hexafluoride -- that have a different release pattern but the same general story.

And they help us tell how old that water is.

Where is the footprint in the groundwater -- of post-1952 water that could potentially be associated with the releases from the compressor station?

Go ahead and advance again.

This is what this looks like in practice.

And Roger showed a picture of that, too.

It's quite a large number of bottles going off to eight different labs for just a wide range of chemical analyses.

And that's why it takes four hours -- three to four hours to collect a sample.

Just a lot of -- that's a lot of water coming out of these wells.

PG&E and their consultants were really concerned that a number of these wells wouldn't produce sufficient water to do this.

We had to do some special extra work on some of these wells, come back to them over the time, in order to make sure we got enough water for all these analytics.

Go ahead and advance.

There we are in the field.

Again, there's a picture of Roger and Betty watching the sampling operation.

Probably should have them pose again so you could watch those shadows sort of move across the road as the sun came up in the east and set in the west.

Because we literally were there all day long.

And, you know, the crews work very hard in order to get those samples.

Go ahead and advance again.

And I mentioned the rock numbers and that we measure those in terms of parts per million or milligrams per kilogram.

And that things like chromium VI, we measure in parts per billion [inaudible] chromium VI is actually 0.06 parts per billion -- that's 60 parts per trillion.

And I'm going to give you a little math lesson here.

That's a number line.

You probably haven't seen one of those since first grade, perhaps.



I think they probably use those a lot nowadays to confused kids with math.

But what we can see here is, there's the rock and alluvium out here.

Each division here is a factor of 10.

So I don't have a good illustration for weight -- because this is actually weight that we're talking about -- parts per million, milligrams, grams per liter of water.

But I can give you this illustration pretty visually with length.

So here, right here what I'm holding up, is 39 inches -- a little bit more than a yard.

If I were to divide that by 10, I've got about 4 inches.

Takes me over to the first division here.

If I were to divide that again by a factor of 10, I've got 1 centimeter, or about a half an inch or so.

If I divide that one more time by a factor of 10, I've got a millimeter, which you certainly can't see from here.

Kind of over here.

If I divide by 10 once more, and by 10 again after that, we've got about the thickness of my hair.

So one, two, three, four, five -- we're over in this range here.

And we're measuring things that are way down here -- 10 to the minus 18th -- so that's 1 divided by 10 18 times.

10 to the minus 21st -- 1 divided by 10 21st times.

The only practical thing that you'll get out of this little discussion is femtomole is a great word if you're doing crossword puzzles. [laughter]

And if you really want to impress your friends the next time you're playing Scrabble, try atto.

They won't believe you until they look it up.

But people measure these sort of things very precisely and in great detail.

Rock and alluvium is out here.

Major ions -- seawater is up here.

You can actually measure that in parts per thousand sort of range.

Most of the major ions and nutrients that we measure out here in the Mojave Desert would be in this parts per million range.

That would be 1 divided by 10 six times.

Detection limit of chromium -- out here -- 60 parts per trillion -- 0.06 parts per billion.

And then these things out here, the chlorofluorocarbons, the sulfur hexafluoride, the tritium, come in a category of things referred to as environmental tracers.

We measure these at extraordinarily low concentrations.

And we measure them for a very particular reason, and that is because they have a behavior and a history that we understand.

And to the extent that it may mirror the constituent of interest, like chromium VI, they may produce valuable information at very, very low levels.

Advance again.

I have no concept in my mind of what a femtomole or an attomole is.

I've worked with this stuff for 30 years, and I just don't have the vision of it.

Darren is one individual on the planet Earth -- there are 7 billion people on the planet Earth.

He's here on that number line.

So each of you are around here someplace, you know, and we're going way, way down below that.



Go ahead and advance again.

This is just the plume maximum.

Some of those concentrations get up into the part per million range, maybe as high as 10 parts per million in the past.

Here's what the background level is here.

It's what we're looking at.

What we're trying to determine that [inaudible] part per billion range.

You can see it's one, two, three -- almost four orders' magnitude lower.

It's a very difficult number to look at.

And because it is so difficult to look at, that's why we use these.

If we can know and measure these, we can understand what might be happening here far better than simply measuring chromium VI.

Go ahead and advance again.

In order to do this, Roger mentioned that we spent a lot of time cleaning and decontaminating our equipment.

We had to do this between our sample collections to measure individual wells.

They're washed with soap.

They're washed with inorganic free water.

Roger didn't mention this, but I'll refer to this again later on, but that little gallon jug of water he had there, that photograph of, it's 40 bucks a gallon.

So if you want to know where the money goes, that's cheap compared to something I'll show you in a few minutes.

But this is a big process.

Takes a lot of time between wells in order to make sure those wells are purged so that we've got fresh water and in order to make sure that the pumps and all the sampling equipment, everything that touches it, is clean as can possibly be because it doesn't take much at 10 to the minus 18th parts in order to contaminate the sample.

Why do we filter samples?

And I know there's a lot of concern in the community as to why these samples are filtered.

And part of that concern is very legitimate.

You don't filter if your water is from your drinking tap.

And so you look at this, and you say, well, I'm drinking a whole water sample.

Why are you filtering?

Why aren't you measuring what I'm drinking?

And part of that has to do with the purpose of the study.

If you're U.S. EPA, and I were doing a public health survey of water levels out here, I might do unfiltered samples.

[inaudible] drinking water supplies from major rivers, and I wanted to know what public health exposure was, I might measure unfiltered samples.

But I'm not a toxicologist.

I'm a groundwater hydrologist.

And the charge that we have as part of this study is to understand what that plume is in the ground and where it's moved and where it hasn't.



And so that's one of the reasons we filter.

Another reason is -- I was talking about contaminating things are very, very low levels.

Rock and alluvium up here may be down to 10 to the minus 6th.

If you take a look at some unfiltered samples -- not all of them -- you can visually see how cloudy they are, how much silt is in there.

And there's material in there that has concentrations of chromium, perhaps, that may be far higher than what's in the ground.

A little bit of this will go a long way to contaminating this and even a longer way, perhaps, to contaminating some of that.

So that's one -- two good reasons why we filter -- the purpose of the study and to minimize contamination and to make sure that we know what we're looking at so the interpretations that we made are what we believe the data are.

Go ahead and advance again.

In order to get some of these very, very low concentrations for some of these environmental tracers, we have to use very specialized sample collection procedures.

And again, this is part of the reason why it takes so long.

And Roger showed you the picture of the copper tubing that we had.

Some of these samples, particularly the chlorofluorocarbons and the sulfur hexafluoride cannot contact plastic. Plastic contains -- so plastic vials that we would store a particular sample in, they would contaminate those samples.

So that's why we have to use copper lines and stainless steel pumps.

Advance again.

The atmosphere contains concentrations of these gases.

If we expose those samples to the atmosphere, they're contaminated.

I'll see it immediately when the data come back if they have an exposure to the atmosphere.

And so these samples have to be collected, in some cases, underwater in order to maintain that barrier between the atmosphere.

As Roger mentioned, some of them are over-filled -- those liter bottles that we overfill three times, sometimes they take 15 minutes for these wells to reach one liter through that small copper tube.

That's 45 minutes of sample collection for one bottle.

Those are actually collected in duplicate.

So there you go.

There's an hour and a half of that four-hour time period that we have.

Go ahead and advance again.

These low, low concentrations, they sound infinitesimally small, but I actually did a calculation.

I worked it out for you.

In that liter bottle, at our detection limit for sulfur hexafluoride, one femtomole -- remember that the next time you play Scrabble -- there are actually 550,000 molecules of sulfur hexafluoride in that one-liter bottle.

When you look at that, I'm just, like, phenomenally amazed at the amount of this sort of we must have produced over the years so that, in the atmosphere, there's enough that you can contaminate one liter of water the world over with these sort of levels.



Go ahead and advance again.

The tritium, with a [inaudible] of 0.02 tritium units per liter, is even more astounding.

In a one-liter bottle, there would be 11,000 atoms of tritium in there.

So we're counting that low.

And if you really want to boggle your imagination, we actually don't count the tritium.

What we do when this sample goes off to Germany, in the lab, is they will de-gas it -- they will remove all the gases from it.

They'll put it in a lead-lined glass container, and they'll hold it for six months.

And they'll let the tritium decay into its daughter product, helium-3.

So tritium has a half-life of 12 years.

You hold it for six months, it's a fraction of half-life.

[inaudible] started with 11,000 atoms of tritium, we're looking at the production of just several hundred atoms of helium-3, and that's what they'll measure.

You know, it's -- again, I confess to you that I have no real concept of what these numbers really are when you start getting down that low, and I've worked with them on a daily basis.

So for you all, I can imagine it's got to be just kind of mind-boggling.

Go ahead and advance again.

So at these levels, how good are our data?

And I actually do have some numbers back already.

These are numbers back from Asset Labs.

They were -- I worked these up March 29, so I guess that would be two days ago.

And some of these -- this is just a comparison.

And one of the ways that we know how good the samples are -- Roger mentioned it -- is because of our internal study design.

And we're going to look at chromium VI and chromium total at multiple laboratories.

So we're going to have [inaudible] not just one lab.

It's going to be two labs and three labs for chromium total.

So we'll look at those numbers and see how good they are, how different they are from the different labs.

Are the labs performing as they think we are?

And there's also internal consistency within the data.

We believe, based on everything that we've seen over the past 20 years of my career, that most of the total chromium, in the systems that we see out here, is really in the form of hexavalent chromium.

And that's what this number is showing up [inaudible] with the data that we have.

Here's a one-to-one line.

We have a very small excess of hexavalent chromium, about 5%.

That's really pretty good.

We're not doing bad there at all.

So we'll see how those numbers continue to produce.

Guys like me who spend time looking at stuff like this -- it's worse than looking at femtomoles.

But, you know, we start looking at numbers like this -- this is an R-squared.

That's a statistical measure of goodness of fit.



One is a perfect fit.

0.99 -- that's darn near a perfect fit.

This little number here is minus 0.10, is actually really significant.

Hard to believe, but the reason I say that is that tells you how much excess, at zero, chromium total we have.

When we did our blank samples, in general, our chromium VI blank samples came back clean.

They're very, very good.

We have 0.1 parts per billion total chromium in there from the pumps.

The pumps are stainless steel.

We know it's from the pumps, or I believe it's from the pumps, because we have our equipment blanks that we did before we went out in the field, and those are perfectly clean.

So it doesn't affect our hexavalent chromium number, which is the number that we're after.

But we can see very small things, very minute things, in the data that we collect.

And to the extent that we can see them, to the extent that it makes sense, gives us an idea of the confidence of our data.

Go ahead and advance again.

Again, how good are the data?

We look at equipment blanks -- I just mentioned that -- before we went out in the field in that six weeks' period of time.

We went and had a signed contract, and when we were actually out there March 1st, we checked every piece of equipment that we had.

We ran that 40-gallon -- \$40-a-gallon water through it.

We sent it off to a lab.

We paid several hundred dollars for analytics.

And we came back with a bunch of zeroes, thank god.

You know, all our equipment was clean.

Nothing was contaminated.

And when we walked out into the field, we knew -- with one exception, and I'll talk about that in a little bit.

Again, for guys like me, look at the little weird numbers -- 0.97.

That's pretty good -- 3%.

We're not doing bad.

Our blank data, we cluster around here -- all the chromium VI values were clean.

Just very small levels of chromium total.

These red dots, we obtained known waters traceable to the National Institute of Standards.

Very expensive, and I'll tell you about that in a second.

The values were 5, and the values were 10.

Asset Labs were able to hit those right on the money, so they're doing very good, both with the blanks --they're doing very good with the replication of the replicate samples [inaudible] part of this.

And they're doing very, very good with the known waters.

You can see for 40 samples, I might have as many as 40 quality assurance samples directly associated with that.

And I have a large number of replicate samples also in order to confirm those data that we did.

Go ahead and advance one more time.



Because nothing everything works perfect.

And this was the one dirty piece in the whole system that we had.

We knew it before we went out in the field, and it was contaminated in the samples by about 0.4 micrograms per liter.

Our detection limit is 0.06.

We couldn't use it.

When we were out in the field, I had a new piece -- two new pieces fabricated on the spot trying to get this piece back into service.

They produced a contamination level of 0.1 part per billion.

Because our detection was 0.06, we couldn't use it.

What that meant for me, as the person who's responsible for running the project, is instead of two crews out there for two weeks to collect these samples, I had to have three crews out there for three weeks.

What that means for Ann is that I'm multiplying in my head in terms of what that bill's going to be and, you know, I didn't predict that.

But that's why.

You know, and we know this is advance.

We don't want to find this out afterwards.

So it's really important.

Let's go ahead and advance again.

This is what it takes to do that.

This is just a sample set of materials that we do in order to do one known water analysis.

The real key to this is the certified analytical chain of custody form [inaudible] traceable back to National -- the NIS standards.

And somebody willing to sign off that this was prepared according to the best of their ability and that they guarantee it's certified that the concentrations that we produce are in fact what they are.

And we talked about -- a couple times, I mentioned that gallon jug of water that was certified clean of chromium that costs \$40.

This is a 15 mL vial of reference concentrate.

I mentioned it was a pre-measured, pre-weighed 485 mL of inorganic free water that they provide in a Teflon bottle.

This costs me \$460.

In order to get it FedEx -- it has a 24-hour lifespan, so we produce that right out in the field.

We ship that out.

If you do the math, this is \$3,900 per gallon.

You'll be getting the bill, Ann. [laughs]

So this is not cheap.

Good science doesn't just happen.

It happens with planning.

In this case, a lot of involvement from the board, from PG&E, from the community.

And it's expensive.

In order to guarantee you that we're producing the numbers that we say that we are, this is what we do.



Go ahead, advance.

And again, here's another timeline, but this is time in months.

And this is intended to give you an idea of the turnaround of some of these samples.

You're taking samples from your well, going down the hill to one of the labs down there and getting your results back maybe within a couple days, maybe within a week.

The turnaround on the chromium VI samples that we have is 10 days contractually to actually analyze those contractually within 24 hours.

But some of these samples take a long time to produce.

The dissolved and industrial gases that we collect -- anywhere from three to six months.

Assuming a machine doesn't break in the laboratory in Reston.

Carbon-14, strontium, and chromium isotopes -- anywhere from six to nine months, again, assuming that an accelerator someplace at Woods Hole doesn't have a problem with it or Fukushima doesn't blow up again and the equipment is diverted for a more important societal use.

Some of the access to this is for USGS, and some of these people I have known my entire career.

John Fitzpatrick that's there with his TIMS machine.

That's not a nickname.

That actually stands for thermal ionization mass spec.

It's a very complex piece of equipment.

John is one of only two people I know in the world who can actually do this sort of analysis.

So it's very specialized.

One machine to handle all these analyses.

So the throughput for that lab is slow.

It's not the actual analyses itself, it's just doing the 40 of them during the course of time.

It's likely to take as long as nine months.

The tritium, the helium-3, I mentioned before, they go off to Germany.

They will sit in a lead-lined bottle for six to nine months before we think we have enough helium-3 in that sample to go ahead and analyze it.

So we won't get results back from this phase of study for almost a year.

And fortunately, we have a five-year study.

The study is designed to be iterative in the sense that we go out in this first phase of sample collection, and we use the results from that to inform us from the second phase of sample collection.

But we can't start that second phase until we have these data back so we know whether to move further out, move closer in, which wells were best to sample.

And it's going to take a while before we see those results.

Some of them come back early.

You've seen some of the quality assurance samples already from the chromium total.

And the CAC, the TWG, we'll have plenty to talk about as these data come back.

But the final decision -- as you saw, that tritium was way, way out there on the end of that number line, I would consider probably our single most valuable data point for the problem that we have, we have to wait.

We have to be patient.

Go ahead and advance again.



And what's next?

I'm not going to sit around for a year waiting for things to happen.

I've got a job.

I've got things to do.

I've got a project for you guys that I need to complete.

So I've got some project management tasks.

Contractually, I owe Ann a timeline of how this project is going to move forward, what we're going to do when.

I have some project reporting tasks.

I owe the community a lay-reader report describing what I've just talked about.

So, you know, you may actually see something like femtomoles or attomoles in print.

Be the only time in your life you'll see something like that.

But that side, I have to make that understandable so that people in the community can look at it and understand what I'm trying to do, what I'm trying to convey.

And again, in a lot of ways, it's easy.

Because the questions that the project is designed to answer were questions that were posed by the community -- questions that you've had for years, and perhaps in some cases, decades of information that you felt that you were lacking in what was being presented to you.

And this is an opportunity that those questions could be answered.

So what I really need to do is to find what those questions are for you and at least assure you that you may not understand the exact analytical tools that we use -- the mechanisms that we get there with.

In fact, I have to confess that I, myself, don't even have a visual concept of what some of these very, very little numbers are.

But they will work for us.

That they are the best possible data that we can obtain.

Some of these work needs to be started and moving forward sooner rather than later if we're going to get this project done on time.

Task four -- evaluation of local conditions.

One of the things that we want to start sooner rather than later is get out there and start measuring how these wells perform, with depths on these extractions wells, some of these long-stream wells.

Very complicated process.

Some of it involves heavy machinery.

Very detailed measurements of flow through wells in pumping and un-pumped conditions.

And this would be in support of task five.

Go ahead and advance again.

Task five being numeric model development and support.

[Ridell] mentioned numerical models.

They are tools that we use in order to predict things that we can't measure.

Some of the things that we can't measure are what happened in the past.

Of great interest to the community -- you know, what happened to the chromium plume between 1952 and 1964, and actually up until 1990 when present-day data collection techniques and intensive monitoring was being done in the Valley.



So it is a tool that we can look at in order to start answering some of the questions that the community has. But we have to collect data in order to support that tool.

Go ahead and advance again.

And finally, task eight, the fate of chromium within an in-situ reductive zone.

What actually happens to it?

We've gotten materials furnished to us from drilling that was recently done out here by ARCADIS.

That's a picture of aquifer material there.

Notice the gray color.

It's reduced.

There's no oxygen within there -- those materials when they were collected.

[inaudible] Menlo Park.

They were handled under a nitrogen atmosphere so that they could never -- they were not exposed to oxygen.

They're collecting stainless steel liners.

You can actually see a little bit of [rind] here where a little bit of oxygen bled through the metal and oxidized those materials.

But all the material that we have to work with is actually still reduced and still in the condition it was in the ground in the IRZ.

We're designing experiments to look at this very closely.

You look at the permanence of that treatment system.

The lab that will be doing that is the USGS Geomicrobiology Lab in Menlo Park.

There's some pictures again that were taken by [Ridell].

This is the same lab used by NASA to look at extreme [inaudible] and extreme life from places that may potentially exist -- places like Titan, Io, Callisto, which are the moons of Saturn and Jupiter.

So this lab is unique in the world.

And basically, what it does typically -- and again, I just consider myself real fortunate that I was able to plead with Larry Miller to get me in there and do this work for us.

Go ahead and advance again.

And I do learn some practical things as I do this.

And, you know, I have a lot of people who work for me, Krishangi being one.

And when not in the lab, she runs around and collects rocks.

And if she has someone with her, you would think you would get twice as many rocks, but two geologists only produced bigger rocks, and they were really -- advance one more time -- they were quite proud of themselves when they came back with this rock.

Hitting it with a sledgehammer -- I guess it's a welded [inaudible] of some sort.

And it would ring like a church bell.

It was really a pretty cool rock.

So that's what we've been doing for the 10 weeks or so since we started the project and the three weeks or so we've been in the field.

Community Member: Dr. Izbicki?

Dr. Izbicki: Yeah?



Community Member: Can you tell us briefly what these maps are over here so the community can take a look at these, what you've brought?

Dr. Izbicki: Sure.

The USGS has produced a report.

It's not quite online yet.

I was hoping it would be online for this meeting so I'd just give you the URL to look at it.

But there are interactive data sets that will be posted within a day or two.

Those are maps -- mockups of those data.

And they represent -- there's a number of trace elements, and I only printed off a few of them for you.

Community Member: So there's arsenic, manganese . . .

Dr. Izbicki: Manganese, chromium, uranium in the Mojave groundwater basin and the Morongo groundwater basins out here.

So you can take a look at that.

As part of interpreting the data that we have and that we'll be collecting, they serve as benchmarks for me.

Because one of the questions that I was getting asked is, well, how high is high?

How low is low?

Well, it depends on what is out there.

And this is our measure -- the data that we have available [inaudible].

The other thing you might want to inspect is that map over there that shows -- thank you, [NASA?] [laughs] -- that shows the wells that we sampled during the past three weeks.

So if you have any questions, I'll be happy to address them now.

Community Member: Thank you very much.

[Applause]

Community Member: We can all have a geology certificate, right?

Dr. Izbicki: That's right.

Three credits at [inaudible] Community College.

Female Audience Member: Will you put this on the Hinkley project web page for the USGS, or just in this presentation?

Community Member: I suppose that you guys will put it on the [inaudible].

Committee Member: Yeah, we'll put it on the Hinkley groundwater [inaudible].

Community Member: Right. HinkleyGroundwater.com?

Wonderful.

Dr. Izbicki: it'll be up there.

I need to do some revamping of the USGS web page.

So it probably eventually end up there.