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MAGGIE HANNA

Date and place of birth (if available): June 11, 1958 in Calgary, Alberta

Date and place of interview: May 1st, 2013; Maggie Hanna's home in Calgary Northwest

Name of interviewer: Peter McKenzie-Brown

Name of videographer: Peter Tombrowski

Full names (spelled out) of all others present:

Consent form signed: Yes

Transcript reviewed by subject:

Interview Duration: 1 hour, 38 minutes

Initials of Interviewer: PMB

Last name of subject: HANNA

PMB: I am talking to Maggie Hanna. Maggie is the second geologist that we've interviewed for this project. She is doing a lot of work for Suncor and other companies related to oil sands. And, I really want to understand the geology of the oil sands business and the origin and those kinds of issues which you can present to me and I really can't ask the right questions. My ignorance is so great. So, today is the 1st of May and the interview is taking place in Maggie's house in Northwest Calgary. And, Peter Tombrowski is our videographer. So, would you mind very much Maggie telling me, first of all, where you were born, when were you born?

HANNA: I was born on the 11th of June, 1958 in Calgary in the Holy Cross Hospital. I've been a resident of Calgary my entire life even though I have a penchant for travel and have seen a lot of the world. This has been my base for my whole life.

PMB: Where did you go to school?

HANNA: Henry Wise Wood for high school, Milton Williams for elementary and junior high. The school, Milton Williams has since been torn down as the 66th Avenue, Glenmore under-pass and over-pass was built; and then the University of Calgary.

PMB: So, you really have been a Calgary person from the beginning?

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HANNA: That's right

PMB: Would you mind telling me about your career? Would you just start by telling me? Once you got out of university you studied geology?

HANNA: I did.

PMB: What degrees did you get?

HANNA: Bachelor of Science in Geology is the only degree that I have. It was both mining oriented and a petroleum oriented degree. My initial interest was in mining. So, I spent seven seasons in the field, both to put myself through school and also after school, doing hard rock geology in gold and copper/moly, uranium and industrial silica. And, basically being a field geologist. When I was younger that was holiday with pay, because, I could be in Nature and geologize and pick up rock samples, make maps and the helicopter would come find me at the end of the day and take me back to camp. It was holiday with pay until I got a little bit older.

PMB: Now, copper/moly which is short for molybdenum.

HANNA: That's right. Copper and molybdenum commonly occur in deposits together because of their chemistry.

PMB: So, continue. You really enjoyed the mining side?

HANNA: I did.

PMB: You were thinking in terms of mining metals?

HANNA: Yes, that's correct. However it wore thin after a while because I got lonely; being away from family and friends for four to five months every year, being in the bush got lonely. So, I decided I'm going to change this. I went back to university and I was thinking about getting into the petroleum side of things. I took some petroleum grad courses. I taught some labs in sedimentary petrology, and was a research assistant with a remarkable sedimentologist prof Dr. John Hopkins. I got a job with Dome Petroleum and I was the only summer student hired on that year because John knew Harry Suey, who hired for Dome. That was at a time when the oil patch was in one of its cyclical dumpster moments. I was the only person hired on that summer. Dome Petroleum was the perfect company for me, because it had a very entrepreneurial spirit. They gave a person all the rope you needed to absolutely excel or hang yourself. John Andriuk was the VP of Exploration at that time. He's still kicking around and still playing with some geology in Saskatchewan at the moment, last time I spoke with him.

PMB: In those days, of course, Dome was associated with natural gas, Beaufort Sea oil and to some extent heavy oil. Were you involved in the heavy oil side at all?

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HANNA: No. I wasn't actually. I was involved with the natural gas side. In fact, I am to blame for siphoning off the natural gas from what are now the heavy oil deposits being exploited these days especially around the Lloydminster area. So, you could say it's my fault that the gas caps are gone.

PMB: Okay. Please tell me about that. So, you found these shallow gas reservoirs and used them. What was the impact of that on the heavy oil reservoir?

HANNA: Well, if you take the natural gas out of the heavy oil reservoir you reduce the reservoir pressures, which means you are less able to produce the heavy oil.

PMB: Was this the kind of heavy oil you could produce cold?

HANNA: You could. It was the extra heavy oil. So, it would move slowly at reservoir temperature. And, it was the bane of my existence, because, it was my job to find and exploit natural gas to supply the Birch-Wavey Contract. So, we would drill wells looking for gas in a number of the Cretaceous heavy oil and gas bearing formations including the Colony, the General Petroleum, the Rex, and the Waseca, et cetera. And, wouldn't you know it, the heavy oil would flow into my wellbore and plug off the gas production. We'd have to go in and use solvent to clean them out just to get the gas flowing again. It was the bane of my existence at that time, that dang heavy oil.

PMB: Now, how would you compare the heavy oil in the Lloydminster area to what you later learned about the heavy oil up in other parts of the province and heavy oil/bitumen?

HANNA: Right. There is a remarkable difference between the heavy oil in the Lloydminster area and the bitumen in the Wood Buffalo Municipal District. Heavy oil is a liquid at reservoir temperature and bitumen is a solid. This key difference in the viscosity is sort of related to API gravity. API, it is basically a calculated specific gravity standard devised by the American Petroleum Institute, I think.

PMB: It is.

HANNA: The definition of heavy bitumen is less than 10 API and I think more than a 10,000 centipoise viscosity. So bitumen is a solid in the reservoir whereas extra heavy oil is a liquid at reservoir temperatures; a thick one, but it's a liquid. So, how you get each of those hydrocarbons out is very different.

PMB: So, 10 degrees API, that basically is water, isn't it?

HANNA: Yes, the specific gravity of water is defined as 1, which equates to 10 API. And, the specific gravity of Athabasca bitumen is about 1. If an oil has an API gravity of greater than 10 then it will float on water. There are other things that come into play like wax content etc. so the relationship between API and viscosity is not absolutely direct. For reference, a super light oil like condensate, has a viscosity much like gasoline and has an API> 45-ish. So, at room temperature and pressure, our Alberta bitumen has an API gravity of about 8, with a viscosity of over 1 million

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centipoise and a specific gravity close to that of water. So, it's very difficult to separate bitumen from water at room temperature.

We have to do some things to it to make that separation happen. One of the things we do is we heat it up. As you heat up bitumen it melts, the specific gravity goes down, so it gets lighter than water. Actually, technically, as you heat up the water the specific gravity of water goes down as well. It doesn't stay at 1, but still the bitumen will slightly float on water at higher temperatures.

PMB: It becomes steam.

HANNA: Well, actually water gets lighter even before it gets to be steam. So, around a little over 50°C bitumen will float on water. We mine the bitumen ore, mechanically break the chunks up, add hot water and a certain size of air bubbles in transport pipelines to make a frothy slurry. Then we pour the resulting slurry into a big hot a vessel. That vessel operates best at a little over 50°C. The bubbles rise through the bitumen in the vessel, and sticks to the blebs of bitumen in a froth. This makes the combination of air attached to bitumen lighter than water, and the resulting froth rises and pours over the sides of the vessel to be collected. The process leaves behind clean sand, well….pretty clean sand. That's how we extract the bitumen from the ore.

PMB: Now, when Karl Clark developed that system roughly 90 years ago.

HANNA: Yes, early 1900s.

PMB: Maybe 1920.

HANNA: Yes.

PMB: But, he came up with the formal system. But, he was also adding certain chemicals. And, I'm trying to remember what they were.

HANNA: We add a little bit of sodium hydroxide which is a base to this vessel as well. Mostly that has to do with stabilizing the clays that come along with the bitumen ore. So, it has more to do with the clays than it has to do with the bitumen itself. In the past, we have tried all sorts of chemical additives and surfactants, but nothing works better than plain hot water, so we can't justify the additional cost.

PMB: So, the chemical content of oil sand, now let's get away from pure bitumen, let's talk about the oil sands. The chemical constituents of oil sands includes: rock, sand and clay. But, as I understand it the grains of sand are coated with a very thin layer of water which basically makes it very difficult to take the bitumen off.

HANNA: Close but no cigar. That water film actually makes it possible. So, if we took a mitt full of bitumen ore and we had a close up look at it. We would see lots of quartz sand. We'd see other grains too like a few feldspars, and heavy minerals in there. We'd see some clay and the bitumen.

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There would be salty formation water in there as well. And, if you zoomed in further, you'd see each sand grain actually has a very thin water film coating around it, which is about 10 microns thick. We call that "water-wet". That water layer keeps the bitumen from strongly adhering to the sand grains. And, that's why when we heat up the sands we can actually wash the bitumen off the sands. Down in the States they have "oil wet" oil sands so they have to use solvents to get the bitumen off the sand grains. Our hot water process doesn't work for them.

PMB: Where is that?

HANNA: Eastern Utah. So, our process uses hot water to start with and in their process they have to use solvent. They can't even use steam to get stuff off theirs because they don't have that 10 micron envelop of water that keeps the bitumen from sticking absolutely onto the sand grain.

PMB: Well, isn't that interesting. All these years I had thought that it was the opposite?

HANNA: That little water envelope is absolute gold for us.

PMB: Now, what I understand and perhaps you can clarify this, is that when you take a bucket of oil sand you end up with so much bitumen, but then you end up with a bucket and a half or something of sand; because, it's closely held together by the bitumen that by rejuvenating the bitumen the sand actually expands?

HANNA: I don't think that's true, actually. When you take a bucket full of ore, you're at the surface. There is about 35% porosity in that ore and that 35% porosity is filled with about 8% to 14% bitumen and the rest is salt water, formation water. So, once you take the bitumen and the water out of that ore, you're left with sand and you don't have any more sand than you started with. In fact, you have a little bit less. And, the reason for that is that those sand grains are not cemented together. In fact, they are almost floating in bitumen. So, when you take the bitumen out you actually have a little less in volume than you started with.

PMB: Well, I'm not going to give up on that. When I went up to Syncrude they told us that they actually were having problems get rid of the sand, because there was more of it after they did the processing than there was before. Mind you, that was a long time ago; that was when the project just opened. Well, we mustn't argue about that point, because you probably are right.

HANNA: Somebody told you something at some time.

PMB: Now, the idea of solvents, a lot of the companies, Esso is a really good example, are now experimenting with using solvents instead of steam. Part of the argument is that if they can effectively use solvents to release the bitumen from the reservoir. Then they invest less money in energy and they reduce the amount of carbon dioxide emissions.

HANNA: Exactly.

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PMB: Can you give me any comment on that?

HANNA: I think it's true.

PMB: Tell me about that. What do you know about these solvent processes?

HANNA: Well, solvents are being experimented with now in SAGD processes. There are several different companies using several different solvents. Some of them are combining solvents and steam together and injecting them together. Some people are working with solvents alone. The challenge is getting the solvents back. They are expensive. It is not clear yet that we can do this cost effectively. I can tell you that there is a large greenhouse gas footprint when you are making steam. You are burning natural gas and the flue gasses that come off those boilers are probably 6% CO_2. You're making steam and you're injecting it into the ground and you get an emulsion back that might be 30% bitumen. But, to get that emulsion back you have to burn a lot of natural gas. That's what we're using right now. We're looking at other ways of producing that steam, more efficient ways. Perhaps, solid oxide fuel cells. There is an Alberta Innovates led consortium right now and we're looking at using solid oxide fuel cells both to the generate steam and produce sequestration ready CO_2.

PMB: What kind of oxide?

HANNA: Solid oxide fuel cells, SOFCs they're called. There's another one of those dastardly acronyms. But, these things will produce heat of about 700°C which can be used to make steam. They produce some electricity as well. They run on hydrogen that can come from methane and use a chemical process instead of a combustion one, and they are significantly more efficient maybe 80% efficient. So, we're looking into that as a group of companies as we speak. That is a real possibility for the future steam generation for SAGD.

PMB: Would you talk a little bit about sequestering carbon in this way?

HANNA: Carbon sequestration needs a relatively pure CO_2 content in order to inject it into a deep porous salt water bearing formation. SOFC's give off a pure CO_2 stream so you don't have to try and concentrate the CO_2 from a combustion flue gas stream. I'm not as up on it as I'd like to be to be able to speak much more about it. I don't want to give you bad information.

PMB: Fair enough.

HANNA: We can talk about sequestering carbon in other ways, if you like.

PMB: Now, I got you off topic. You were kind of reviewing your career and I forgot to ask you about your husband? I believe you have a son?

HANNA: I do. My husband's a geologist.

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PMB: And, his name is?

HANNA: Kim Roman. And, he and I met in Metamorphic Petrology class.

PMB: That sounds like a bad omen.

HANNA: Yes. We "studied" together and were very competitive with each other around marks. It was a very real competition. But, we survived that and here we are. We adopted. We have a 17 year old son named Scott Roman.

PMB: That's your personal life. Now, your career please….

HANNA: So, I was working with Dome Petroleum and I just have one little story. The president/CEO of Dome at the time was...

PMB: Jack Gallagher?

HANNA: Jack Gallagher. And, I had been hired by Dome and had been working my first job for about two weeks. I'm in the elevator and I'm going up to my floor and here is this guy in the elevator and I didn't know him from Adam, but it was Jack Gallagher. And, he greeted me by name. He said, "Hello, Maggie Hanna." I said, "Hello, who are you?" It was Jack Gallagher. I went to school with his son Fred Gallagher, actually who is a gem of a human being as well. Both of them were princes of human beings I think; so, what a guy.

PMB: I had a similar experience. I met him once in an elevator and I just said, "I admire you so much and I just really am so proud of what you did." And, he started to talk to me and he missed his floor -- he got off on the wrong level. But, he was great.

HANNA: He would put people before his elevator stop, yeah.

PMB: Okay, continue. You're with Dome now….

HANNA: Right. So, I was with Dome and the stock went down, there were troubles and we were going into a hard time in terms of oil price. And, I just decided I couldn't get a well drilled for love nor money. I put one the best prospects I had ever come up with on the table and I couldn't get land money to buy the rights. I just knew we couldn't win at land sale. I had found the sub-crop end of Meadowbrook-Rimbey Leduc reef trend in amongst the Grosmont. It had about 6 BCF recoverable gas per section, and then were a bunch of sections available and people thought it was Grosmont. But, it wasn't. It was Leduc which is a much better reservoir. And, we missed it. Paramount beat us out on that one. So, I just decided I'm going travelling for a year. I took a sabbatical. And, I said, "I can't get anything done."

PMB: Were you married at this time or not?

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HANNA: No. We were living together.

PMB: I'm shocked.

HANNA: I know, I know. You've got to try a pair of shoes on before you buy them.

PMB: So, you left your hubby here and you travelled the world?

HANNA: We. He and I went together.

PMB: Oh, did you?

HANNA: Yeah, we went together. And, by the time I came back Amoco bought Dome and my job had disappeared in the process and that was that.

PMB: So, that would have been 1968?

HANNA: I was a Brownie in 1968.

PMB: Sorry, 1988. I ended up working for Amoco.

HANNA: Oh, did you.

PMB: So, you went off and were travelling around the world. Where did you go?

HANNA: We flew to Holland we toured through Holland and Belgium and France. And then, across to England and Scotland, Ireland, Wales. And, by the time we got Wales it was miserably cold and damp. We were travelling in an old green Fiat cargo van that we had outfitted with a bed of sorts and a blow-up mattress. By the time we got to Wales, it was winter and it was cold and you'd wake up with condensation dripping on you. And, we just decided we'd park our van in Cardiff, Wales and we flew to Thailand. We toured Thailand and Nepal and India. And then, we went back and sold the van and toured by train back the way we came and into Germany. And, from Germany back to Holland, then home.

PMB: That sounds, around the world.

HANNA: It was a year, yeah.

PMB: Good for you. Going back in your life, when did you actually first hear about the oil sands?

HANNA: Well, I heard more about the oil sands first when I was about halfway through my career. I was a consulting geologist. And, I worked for small companies doing project work, really as geological guns for hire.

PMB: Through your career?

HANNA: About that, yeah; about halfway through.

PMB: Seriously?

HANNA: Yeah. So, for the past 15, 20 years I've worked consulting for small companies mostly. And, I mean not entirely but mostly. Some people wanted me to do oil sands projects and I said, "No way. I'm not doing that." For two reasons: 1) at the time I looked at the energy intensity that is required to make a barrel of synthetic oil. And, then I looked at the energy intensity of lifting a conventional barrel which was substantially less. At that time the basin was less mature. It was much easier to produce a conventional barrel than it is now. 2) The most important reason for me, I am a rock oriented geologist. I love [drilling] logs, logs are great. But, rock doesn't lie. So, I look at a lot of rock. When you're looking at oil sands core, two things just bug me. And, one is that the gases that come off that thing, it's like standing downwind when you're filling up your gas tank. You're whiffing fumes all day. And, I just didn't want to do that. I didn't think that was healthy.

And, the second reason was that when you're looking at bitumen saturated oil sand, you can't see squat all because the bitumen just hides all the sedimentary structures, all the bugs, all the trace fossils. You can tell the difference between shale and sand, otherwise you've got to dig at it and wash the bitumen off it with nasty chloroethene and then you have to look at it under the microscope to even get a grain size. It's no fun.

PMB: That's quite interesting.

HANNA: Yeah, it's no fun for me. I mean, lots of people do it. Lots of people love it, because it's a great challenge. No fun for me.

PMB: One of the stories that I've heard about the oil sands is that, for example, if you use fracking and you fracture some sandstone or whatever it happens to be to get out. You're getting high quality oil out of a really crummy reservoir. But, with oil sands what you're getting is low quality oil out of a pretty nice reservoir.

HANNA: Yeah, that's right.

PMB: Very easy for the oil, if it were light oil, for it to flow.

HANNA: Yes, it's true.

PMB: Would you talk about that a little bit please?

HANNA: Sure. We don't frack oil sands ever. It's not brittle enough. There is no point. Really, there are two ways of getting this oil sands resource out of the ground. One is to mine it and you can do that economically if there is a lesser thickness of an overburden stacked above the reservoir. If there is more overburden then it's not economical even to mine it. It's a misconception that people have about oil sands being so lucrative, the economics are actually quite skinny. They just are. And, so

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you can only tolerate about 70 metres of overburden before your mine becomes uneconomic. So, that's one way, to mine it. And, the beauty of that is when you mine oil sands your recovery factory is almost 95%. You get 95% of the oil out that you can then use for product, which is much better than even conventional oil recoveries. If you're doing 30% conventional primary recovery, you're doing well. With secondary and tertiary production techniques, you might get up to 50% recovery.

So, we get almost 100% recovery by mining bitumen from oil sands. But, we only do that when the overburden over top of that deposit is skinny enough. Second way, when there is enough overburden to hold a high enough pressure in the reservoir, is to use SAGD (steam assisted gravity drainage) as the key way of getting that oil out. We drill vertically down into the, say the McMurray, and turn the wellbore to go horizontally. Then we drill a second hole right beside it and we place our second horizontal hole directly underneath the first one, with about a 5 metre stand-off between the two. In the top hole we inject steam, from the bottom hole we produce the hot bitumen and water emulsion. That emulsion is composed of melted bitumen, the steam melts the bitumen. So, it's a melted liquid bitumen. And, you can imagine this like a candle and a candle wax. A candle is pretty solid but right up near the flame, you got a little pool of liquid stuff. Bitumen is just like that. So, we heat up the reservoir. We melt the bitumen. The bitumen then is combined with the steam condensate and a little bit of formation water and it's produced as emulsion from the bottom horizontal hole. That's how we get it out. And, in order for that work you actually have to have enough overburden to be able to handle enough pressure to drive steam through the reservoir.

PMB: It has to be enough that it won't blow out from the pressure of the steam. There have been a few awful accidents.

HANNA: Yes. There have been a few steam holes in the ground that looked like geysers where there ought not to be.

PMB: One of them was at Jocelyn.

HANNA: That's correct, yeah.

PMB: And, there was another one at T-Pad at Imperial about 15 years ago. So, there have been some terrible accidents.

HANNA: But, that is how you learn. And, that's why innovation is so important in the oil sands. To be able to say, "While we're figuring this out, failure is an option." Because, you have to be able to be willing to fail in order to try something new. So, that you learn from that failure and then next time you fail better, until you get it right, until you get it so it works. I mean, right is not the term; until you get something that works. So, there's been a lot of innovation and it continues to this day. Some of the things we're looking at now are radical, they're radical. So, innovation is key.

PMB: Now, the creation of SAGD, to what extent did that require new technologies? For example, the ability to drill one horizontal well and then make sure that the second one is 5 metres away and on the same level?

HANNA: Well, it's interesting that you should ask that, because Petro-Canada did the first experiments with SAGD. It was called the MAISP project. And, I don't remember what it stands for anymore, maybe Mine Assisted In-Situ Project. But, that was in the days before we even had horizontal drilling. So, what they did was sit on the bank of the Athabasca River where the oil sands outcrop right on the river and they set their rigs up to drill horizontally, because they lay their rigs horizontally. And, that's how they drilled those first horizontal wells in. I can't remember, something like three holes they drilled and they had six vertical wells that were observation wells and they steamed it for a couple of years I think and produced bitumen, about 8000 barrels, in that range, hot bitumen ran out of those holes.

PMB: This is the first I've heard of this. What year was that?

HANNA: Good question.

PMB: Because, in 1987 there was the Underground Test Facility.

HANNA: This is long before that, long before that.

PMB: You're kidding?

HANNA: It started in 1977 I think, Petro-Canada was operator for a group of companies including Esso, Husky, Gulf, and Cities Service. So, after steam injection was done, they drilled another nine core holes to examine the steam chamber that had developed and they cored that zone and got pure, clean, white sand out of there. So, they knew that the recovery factors were very high. It was quite extraordinary.

PMB: Very, very interesting story. In your resume, you say that right now you're involved with mining and SAGD reclamation processes.

HANNA: Right now what I'm doing is innovation and technology scouting for the oil sands.

PMB: Does that mean you're looking for people or are you looking for technology?

HANNA: I'm looking for technology. I'm looking for new physics. I'm looking for new ways to do things. The primary focus is on reducing greenhouse gas emissions, reducing energy intensity, reducing environmental impacts at the same time as reducing our cost of production for a barrel of oil. That's what I do. So, I'm a spherical thinker.

PMB: You use that in your resume. Does that mean you think in circles?

HANNA: I do that too. I do. It means… I'll give you an example.

So, oil sands has a lot of Vanadium in it. And, Vanadium is an element that is number 23 on the periodic table, it's a transition metal. Right now it's used primarily for hardening steel. Now,

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Vanadium is a fairly abundant element on the planet. But, Earth's processes don't concentrate it very well. So, most of the Vanadium that we have comes from processing uranium ore. It's a by-product of making uranium from the carnotite group mostly.

There is a new technology coming, very much like the lithium batteries that we use in our Prius's and our hybrids. But, instead of a lithium battery it's a Vanadium lithium phosphate battery. And, this battery promises to have 4 to 11 times the charge density of a lithium battery. What that means is, instead of going 100 kilometers on a charge for the same size of battery, you can go 400 kilometres at least and maybe 1100 kilometres. It's still in development. We'll see. But, that's the range we're looking at here. That's a game changer. Where is the Vanadium going to come for those batteries?

China has got the biggest deposits, then Russia and then South Africa. China has made Vanadium into a strategic mineral. They won't let it out. Russia is not as dependable as they used to be and then there is South Africa. So, where is the Vanadium going to come from? If you took all of the Vanadium, out of all the bitumen, from all the bitumen producers, in all of the Alberta production today, you would have one-third world production. That is a lot.

So, this is an example of spherical thinking. It's to say that, here is something else that we have in the bitumen that could be of value. If we had a way to take the Vanadium out of the bitumen (a) we wouldn't be poisoning our catalysts in the hydro-treaters… which Vanadium does, and (b) we wouldn't be getting Vanadium into hydrocarbon products which is not a good thing because if you make diesel out of that, Vanadium oxides form in the diesel engines and actually wear out the engines prematurely. So, if you could remove Vanadium from bitumen early you wouldn't have either of those two problems. And lastly, if you are a company that cokes and not every company cokes; but, if you're a company that makes coke out of the asphaltenes then you have a high amount of Vanadium in your petroleum coke, about 1,000 PPM. And, that petroleum coke has a potential application to be applied to marginal farm land if it is graphene. I think it is graphene, I'll have to prove it to myself yet, but I think it is graphene which is what biochar is made from. Biochar is the greatest of all soil amendments and carbon sequestration methods.

Biochar is formed when you take wood and you put in a pyrolytic process, heat it up to between 400°C and 600°C. You change the carbon into a form that is a sheet, one molecule thick. This carbon looks a bunch of hexagonal cells stuck together like a honeycomb. So, all of these carbons are bonded together in these hexagonal little honeycombs, one molecule thick and that's called graphene. That graphene has internal porosity in the middle of those hexagonal spaces so you can put water in there. You can put potassium in there. You can put phosphorous in there. You can soak it in compost tea to charge it. And, then you spread it on farmland. In boggy conditions, it drains the soil better. In dry conditions, it takes the water into it in the spring flood and then gives it to the plants all summer.

It is also a carbon sequestration sink because those carbons are so strongly bonded, so stable that the beasty buggies in the soil that normally degrade vegetal matter and off-gas CO_2 won't touch this

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stuff as long as there is anything else to eat. It's just too energy intensive for them to try to pluck a carbon off these really stable configurations.

PMB: So, this stuff is in there permanently and it is a benefit to the soil.

HANNA: It's a benefit, yeah. Back to the oil sands now. Cokers actually take the temperature up to 593°C, and biochar forms between 400°C and 600°C. Coke is probably in the form of graphene, …probably. I haven't proven it yet. But, it's also high in Vanadium. Vanadium is a heavy metal. We do not want to be putting heavy metals into the soil for plants to take up, for animals to eat to get heavy metal toxicity. So, if we could take the Vanadium out of the bitumen molecule early in the process, it wouldn't be poisoning our catalysts, we wouldn't be suffering Vanadium in our diesel and other products. And, we would be able to use that petroleum coke as a soil amendment and carbon sequestration method. So, that's an example of spherical thinking. It's not linear. It looks at things from many different angles all at once.

PMB: That was a great illustration. I didn't quite know what I was getting myself into, but very well done.

TOMBROWSKI: Just a question. So, graphene was? How does the graphene fit into this?

HANNA: Graphene?

TOMBROWSKI: Yes? Where does it come from? It is actually produced as part of...

HANNA: Graphene is what biochar is made of. And, Graphene I think might be what petroleum coke is.

PMB: Anything that you want to talk about in terms of your own general career?

HANNA: I got into oil sands because in February of 2009 I was laid off. And, I had some time on my hands.

PMB: Now, you had a private consulting firm?

HANNA: Yes, I did.

PMB: So, how did you manage to get -- did you lay yourself off?

HANNA: No, I did take a permanent gig with a small company, 12 people.

PMB: What was the company?

HANNA: Eagle Rock.

PMB: Eagle Rock, two words?

HANNA: Yeah, Eagle Rock. So, I took a permanent gig with them and when things collapsed in terms of oil price, companies were having a very hard time even finding the money to keep their production going so they sure didn't need an explorationist.

PMB: And, that was after the global/financial crisis in 2008.

HANNA: Exactly right. So, by February, 2009 I was laid off and at the same time, both my parents were ailing. And, so I looked after them until they died in 2011, and in my spare time I looked at the global energy situation. I will just ask you: how many human work hours do you think are in one barrel of oil? So, if you could take all the energy out of one barrel of oil and the energy of one hour of human work, how many hours would equal a barrel of oil?

PMB: I think I know the answer to that. I think it is 19 people working for a year at manual labour. I think it's some number like that.

HANNA: It is 23,000 human work hours. The energy of that equals the energy contained in one barrel of oil; actually, 23,600.

PMB: So, that would be a reasonable number.

HANNA: So, hydrocarbons are a miracle. It's a high density energy packet. And, everything in our society is built on it, everything. It's also a petro-chemical miracle. Paint, plastic, nylons etc. all of that comes from oil. And, so I was thinking to myself that we shouldn't be burning hydrocarbon in our cars, heating our homes with it, we shouldn't be cooking our food on it. There are other energy sources for that; solar, wind, battery technologies. We shouldn't be burning precious liquid hydrocarbon for that. The reason is, is there are future generations coming, they're going to need petro-chemicals. And, we should be saving a lot of the hydrocarbon we are burning for future petro-chemicals. I bet in the future people are going to look back and laugh at us and say, "Can you believe those idiots used to burn this stuff?"

In the future, they'll be laughing at us for the wastefulness that we're currently engaged in too. So, I was looking at the world energy systems and the energy density of solar and wind and geothermal and title and wave energy and molten salt thorium reactors and uranium reactors. Thorium is a favourite of mine, it's like uranium, a radioactive element. And, I'm looking at what the future holds in the days after hydrocarbon. Because, there were days before hydrocarbon and we burned coal. We also burned wood. We also got into whale oil and just about killed every sperm whale in the ocean to get at the oil in its head and along its back. And then, we got into kerosene and into drilling. And, the very first oil well on the planet was near Sarnia, Ontario. The second one a year later was the Drake Well in the United States. And, that has totally changed the complexion of the planet; totally changed what we're capable of doing.

So, we have about a 200, maybe 250 year window of opportunity with hydrocarbon, maybe. I originally thought maybe 200 years, but reserves actually expand with technology; so, maybe 250 years. We're probably 150 years, almost 200 years into that now. What are we going to do after

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hydrocarbon? And, what are the implications of the CO_2 that we are producing by burning fossilized sunlight which is what hydrocarbon is, from 400 Million years ago. What are we going to do? So, I started looking into that problem. And, what I recognized is there are a number of high density energy intense technologies coming towards us from the future, but they're not here yet. Thorium reactors, I love them. Molten salt thorium reactors, we could go into that, but this is about hydrocarbon. Rotational magnetics is another one. There are a number of them, and they're coming our way. Hydrogen from salt water is coming.

So, the problem then is how do we get from where we are now to the time when those things are ready? And, I looked at the oil sands and I thought, "You know what? This is North America's insurance policy for bridging to future high density, non-carbon energy sources." And, as our insurance policy, we have got to be doing it better than we are now. And, I thought about that and I thought, you know, "Why not me?" I have an innovative head. I'm an explorer by nature. I understand I am a generalist in a lot of ways. I understand a lot about biology and physics and chemistry and a little more about engineering now, as well as geology and so why not me? So, then I went to a panel on climate change. And, one of the speakers there was from a major oil sands company.

PMB: What was that oil sands company?

HANNA: It was Suncor. Eric Axford was the fellow, a Senior VP. I was fully prepared not to like him at all when I got there. And then Eric spoke eloquently, truthfully, in real terms, addressing real problems, not shying away from any question that was asked, not going around the uncomfortable. And, I was so impressed by him that I walked up to him after the panel was done and I said, "Hi, I'm Maggie Hanna. I think you need to hire me." And, he said, "Why is that?" And, I said, "Well, you need better technology in the oil sands." I said, "Right now, your upgraders 1940s technology with a little 1960s sprinkled in for good measure and some 1980s instrumentation and SAGD is 1980s. We've got to do better and there are a lot of things out there that I know about that can help this." And, so that led to doing a consulting gig with Suncor I am working on now.

PMB: That was what year? I can't find it on your resume.

HANNA: It was about a year ago, Spring 2012 actually; a little more than a year ago.

PMB: How has that been? Has Suncor been very receptive to new ideas? Is this before or after Rick George retired?

HANNA: I was hired just as Rick George was retiring. I've met him. I like him. Good guy. Sustainability visionary.

PMB: So, tell me a little bit, please, about how that has worked out?

HANNA: I don't want to tell you too much about Suncor, because they're my client. But, in general I would say in the oil sands that there are pockets of innovation. But, in general the culture is one of

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operational excellence and safety. And, when you're talking about operational excellence and safety, there is no room for failure there. It's a success oriented thing. Operational excellence is doing the same thing, the same way, every time, best practice, and not varying from that.

PMB: Operational?

HANNA: Excellence.

PMB: Means that it's a success, or?

HANNA: Means that there is no room for failure.

PMB: There was a different word you used and I just didn't hear it.

HANNA: Safety is the other one. So, operational excellence and safety are the focus of oil sands operations. It's a dangerous game. And, it's important that people get to go home at the end of the day, it's important. So, there is a real focus on that. There is no room for failure in the field. But, in innovation, you have to embrace failure. You have to try anyway. "Success is being willing to fail and fail and fail and not lose your enthusiasm", to quote Winston Churchill, that's one definition of success. Being okay with failure in the lab is how innovation works. And, so it's about embracing failure and if you're not failing at innovation you're not doing much. So, there are these two kinds of cultures, right. Part of my job is also to find the harmony between the two mindsets; the ability to switch from creative thinking to critical thinking and back again on a dime. The idea is to inculcate that not just into the organization, but to every person in the organization. So, they consider themselves both an explorer/innovator and a safe, operationally excellent operator. That means following procedure and at the same time thinking about how this could be better.

PMB: That's a really interesting dilemma. It almost seems as though there isn't room for the two pieces to meet.

HANNA: That's true. If you looked at it from a very masculine point of view, right. And, I don't mean male, I mean that masculine energy is in both women as well as men. And, the feminine energy is in women and men, right. So, masculine energy says a thing is either this or it's that. These things are mutually exclusive. It's either black or it's white and that's a very good thing when you want to move forward and actually take action on something. You can be decisive. The feminine energy is different. It's a "both/and" energy instead of an "either/or" energy. So, the feminine says, this is a 100% true and that's 100% true. And, they are 100% opposite that sets up tension of the opposites if you will. The feminine says, "I'm okay with that." It's a paradox and I'm okay with that, and can exist happily within that paradox… that's the feminine energy. It's to say, both of these are true. They are 100% opposite, 100% true; both of them are true, right.

PMB: Very interesting.

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HANNA: So, it's that feminine energy attitude we what we need to bring to innovation in the oil sands industry. And, the uphill battle of that is that a lot of the engineers, who actually do the nitty gritty designing of this kind of thing, are linear thinkers. Thank you, bless them. There are some people who do that really well and they are also grounded in what they know. Whereas innovation is not about best practice, it's about "next" practice. Best practice didn't get to be best practice without somebody saying, 'Well, what if we did it this way and this is the next practice that becomes then best practice.' Then, innovation goes off and finds the next best practice.

PMB: Now, a few minutes ago you were talking about an idea which was known until three or four years ago as peak oil. The idea that the world's oil reserves have peaked and they are not going to decline tomorrow, but they are going to begin to decline over a period; during a historical period when demand is on the rise. Now, what I have found really interesting about that is it was an important idea for maybe 10 or 15 years and now nobody is talking about it anymore. You gave the big picture, maybe 200, 250 years. But, to what extent have the oil sands played a role in that?

HANNA: There are a number of oil sands deposits around the world. There is Canada.

PMB: There are 78 of them.

HANNA: Yeah. The biggest ones are Canada, Kazakhstan, Russia and although, sometimes we lump in Venezuela's extra heavy oil. Canada's is the biggest. And, particularly if you take not just the Canadian sands, but the carbonates as well, then we've got more than Venezuela. So, conventional basins of the world are developmentally more mature all the time. The big elephants have pretty much been found. And, now we're picking after the little stuff conventionally. We drill deeper and deeper for less and less all the time. And, who knows what's going to happen with that. Certainly, horizontal drilling, certainly fracking oil shales and gas shales is going to get us a little farther down the pike. And, that's why I say that reserves expand with technology. And, there are also reserves to be had in spent oil fields by increasing drilling density and using other recovery methods.

If you only have the recovery factor of 30% that means it is 70% that is left behind because you just don't know how to get it out… yet. But, I see it's so critically important that we have oil sands in North America, because if ever we out-priced liquid transport fuel from the middle class before we have economically viable alternatives, we'd have anarchy. It would be anarchy. Everything gets transported. All the food that comes into Calgary for example. There is only three days of food in Calgary in the supermarkets. And, most of what comes into Calgary is not local, a lot of it comes from California, a lot of it comes from New Zealand and Japan and other places. When it is winter here, it is summer there and they are producing food and they ship their food to us. If oil goes to $300.00 a barrel, $400.00 a barrel then that price is passed down to the price of an apple. And, we will have anarchy.

PMB: I think I've heard that the average piece of food on your dinner table comes from 1300 kilometres away.

HANNA: And, not only that, in North America the energy content of a piece of food in your refrigerator took 20 times that amount of energy to get to your refrigerator. Twenty times to grow it, to put it through a plant, to put in boxes, to put it on the truck, to getting it into the store so that you could buy it. 20 times the energy content of every piece of food in your refrigerator.

PMB: But, now you've changed the question that I asked.

HANNA: Ask again. I've forgotten.

PMB: I was asking you about peak oil and why that idea has kind of faded away.

HANNA: Again, because reserves expand with technology, peak oil is hard to quantify. Certainly, if you look at just conventional oil and gas, yeah there is peak oil. But, we have unconventional now, now we're looking at clathyrates on the ocean margins. And, those are natural gas sources. Just last month, Japan produced the first natural gas 1 kilometre below the sea bed out of methane hydrates, …which are clathyrates.

PMB: I had a book, published in 1919, about the history of the Canadian Oil Industry, believe it or not. And, it talked about a US geological survey report that suggested that the US would be out of oil by 1929. So, this is an idea that goes back 100 years.

HANNA: Yeah, it does, but there is a "both/and" here. Yes, reserves expand with technology advances for sure. But, also is a finite amount. There is a limited amount of hydrocarbon in the subsurface of this planet.

PMB: So, your view and let's go back to something you were talking about a little while ago, is that there are a lot of other potential, good potential energy resources that are out there.

HANNA: Absolutely, yeah.

PMB: That what's really important is to save the complex to hydrocarbons and use them for other purposes.

HANNA: Petro-chemicals.

PMB: For going into the future?

HANNA: Absolutely. That's critically important. We did not move out of the Stone Age because we ran out of stones. I love that quote. I don't even know whose it was.

PMB: Sheikh Yamani

HANNA: Thank you. We're not going to move away from using hydrocarbons as an energy source, because we've run out of hydrocarbons …I hope. But, we have to use hydrocarbon based energy to

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develop these other ways of producing high density energy. And, we also have to put some effort into not wasting so much energy. We waste a lot. I drive an SUV and the miles per gallon on that thing is horrendous. And, the new hybrids that are coming out are so much more efficient, for example, the 2015 plug-in hybrid, the Prius, I think is going to do 88 miles to the gallon. Mine is 22. So, there is technology coming that is going to help us not to waste so much. And, we as individuals, have to decide I'm going to live in a smaller house. I'm not going to live in a really big one, because the energy footprint of heating a big house is irresponsible. It's about living elegantly. And, elegance is a combination of both beauty and simplicity. When we put those together, that's elegance. You can live a beautiful life on a whole lot. And, you can live a beautiful life on a whole lot less.

PMB: Now, about a month ago I read an article, in fact it was related to the Japanese production of natural gas from deep below the….

HANNA: Sea floor.

PMB: Sea bed, yeah, the sea floor. Part of the argument about that in respect to that is that these, I can't remember what they're called, the gas...

HANNA: Hydrates.

PMB: The hydrates, exactly. The hydrates that are in much of the Arctic and under the sea and so on; that if there is global warming it will melt the ice which is keeping hydrates in suspension and then next they'll release methane into the atmosphere which will speed up global warming.

HANNA: I see that as a very real possibility.

PMB: So, let me ask you then please to talk about your thinking about global warming and the impact of carbon dioxide, but even more importantly methane.

HANNA: Methane as a greenhouse gas and has about 20 to 24 times the GHG heating efficacy that carbon dioxide has in the atmosphere. But, it doesn't last as long. Carbon dioxide lasts in the atmosphere forever and methane lasts maybe 20ish years. And, then it turns into water and CO_2, which then lasts in the atmosphere forever. So, for the 20 odd years until ionizing energy splits off the hydrogens and makes water and CO_2, methane is pretty damaging stuff in terms of global warming. And, the methane that is in the Artic permafrost and is along the continental margins is kept there by a combination of pressure and temperature; cold temperatures and higher pressures. If you change those conditions, then you can start off-gassing methane into the atmosphere. Not a good idea. It becomes a positive feedback loop whereby methane gets away into the atmosphere, which increases the temperature of the atmosphere, which heats the ocean, raises the temperature of the hydrates and releases more methane into the atmosphere. It's a positive feedback loop we don't want to get into. So, does that answer your question?

PMB: Yes, it did. In your view, is this kind of thing likely to happen?

HANNA: It's a possible future. The thing about the future is that there are multiple possible futures that depend on the choices that we make. And, it's not like this kind of thing hasn't happened before. Back from the Paloecene to the Pliocene we had much higher atmospheric carbon dioxide levels than we do now. And, if we go back farther and there were several times on this planet where there was not enough atmospheric CO_2 so the whole planet turned into an ice ball. For example, land plants proliferated in the Carboniferous, so by the end of the Permian land were thriving, taking up much of the existing CO_2 from the atmosphere, lowering the atmospheric CO_2 levels to such a point that the whole planet froze from pole to pole for millions of years; which killed over 90% of all species that existed at the time. The loss of life was staggering. It wasn't until the active volcanoes of the time put enough CO_2 back into the atmosphere that the world wide glacier began to melt and life could start anew.

PMB: Isn't the original atmosphere of the Earth helium?

HANNA: It was actually mostly methane with some helium, and some ammonia for good measure, about the time the first rocks were solidifying on the planet.

PMB: Because, I thought I had read that there had been three atmospheres on the planet. There was helium and then I might have heard methane and then gradually the present one of carbon dioxide and oxygen and nitrogen developed.

HANNA: If I remember correctly the next atmosphere was at least 25% CO_2 with some water vapour (a very potent greenhouse gas in its own right) and nitrogen. And then our nitrogen oxygen atmosphere evolved at the expense of CO_2. It was ocean bacteria that developed chlorophyll that ate CO_2 and there emitted oxygen, which at the time was toxic to the life that was there. So, life had to evolve to be okay with 21% oxygen in the atmosphere eventually. And, here we are today. But, the difference is, there have been many times that we've had mass extinctions on this planet. And, we haven't had a choice about that. When a meteor piles into the Gulf of Mexico near the Yucatan and spews enough dust into the atmosphere to keep sunlight from getting to the plants; then most of the plants die and most of the animals die (the big dinosaurs) and it is mass extinction. Only 35% of all life died that time. We don't have a choice about that kind of thing. We do have a choice about this one. Are we going to take action or sit with inaction? I think you protect that which you love.

PMB: A good motto. I like it. I'm going to ask you about one thing, because you're a geologist. I really, really want to know about this: bitumen carbonates and especially the Grosmont. Now, what I understand is that there are bitumen carbonates pretty much all around the world. I believe reading that there is one in Italy, for example. So, why is it that carbonates are so closely associated with oil and especially with heavier oil? So, that's the first part. And, why is it that in Canada we have, for example, the Leduc formation which is a carbonate formation and it's my understanding and please correct me on this, that the formation is very similar to a lot of the formations that hold, for example the Grosmont?

HANNA: Right. Good questions. And, you had another one?

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PMB: If you could do that one. That will probably finish us up.

HANNA: I do not know the answer to the first one. And, I do not know that anybody does know the association of heavy oil and carbonates; particularly, the bitumen and carbonates. I can surmise a guess.

PMB: You see, Leduc is light oil and Leduc is light oil in a carbonate formation. So, there are also examples of light oils in carbonates and why is it that, for example, the Grosmont is heavy bitumen?

HANNA: Conventional wisdom says that has to do with bacterial degradation. The bitumen moved into the Grosmont as light oil and was degraded somehow. It's not entirely clear. Some say that 10,000 years ago the glaciers receded and the Athabasca River cut down into the oil sands, allowing in fresh water and bacteria which feasted on the lighter ends of the oil in place and left the degraded oil behind. Others think it happened because there was fresh water that was moving ahead of the oil that came from the deeper part of our basin in through the porosity of those carbonate rocks and, because it was fresher water, there was more bacterial action and therefore the oil was chewed on by the bacteria and they poop out methane, actually. That's what they do; methanongenic bacteria.

So, I don't think anybody really knows the 100% answer to that question. I think it has to do with the Grosmont being generally shallower than the Leduc. It has to do with the Grosmont having a big long erosive surface that can allow fresh water and bacteria in. At the end of the Paleozoic, big time of erosion when fresh water got into those rocks and causing karsting which is cave formation and dissolution. And, cave formation and fractures that go down hundreds of feet sometimes. Others say maybe it has something to do with hydrocarbon moving into that environment there is already a pre-existing bacterial population that starts chewing on that oil. And, basically degrading it; chews on the light ends and leaves the heavy ends behind. That is the bitumen that's left behind.

PMB: The source of the bitumen that ended up in the sands, the sands obviously the sea bottom at one point?

HANNA: Same oil sources at the rest of the basin, all from organic rich Paleozoic shales deeper in the basin. And, because oil floats on water it tends to move upwards as far as it can go until it getsw stuck in a trap and then we drill later and try to find that trap. A bunch of that oil made it as far as the present day oil sands deposit. And, as far as where the sand where the sands come from, the Canadian Shield used to be a mountain range. Today we can still see the mountain roots in the Canadian Shield in terms of the igneous and metamorphic rocks. There are some very quartz rich rocks there like granites. That is the roots of an old mountain range. As whole area has eroded, the quartz grains, which are tougher than all blazes, survive to form the sandstones. Much of the other minerals like feldspars get turned into clay and those materials are brought by rivers to a shoreline. Now, our Alberta oil sands is kind of right near that shoreline. And, of course the shoreline moves back and forth depending on sea level, relative sea level. But, basically on the eastern side of the oil sands it's a little more terrigenous, which means more land deposition, more rivers and bays and that kind of thing, whereas the western side has more to do with ocean processes. Although, things move back and forth through time, that's a good generalization to make.

PMB: Very interesting.

HANNA: That's where the sands themselves came from. They were eroded off the Canadian Shield.

PMB: You said that you have worked with companies like Cenovus, Talisman, Sunshine and Husky. Anything you want to say about any of that?

HANNA: Well, most of that work was working with my husband, Kim Roman, who does core/chip work. We're both Common Ground Energy Corporation. I do more of the mapping and he does more of the rock work like core, cuttings, scanning electron microscope, thin section work, and the like.

PMB: Common Ground Energy being the name of your company?

HANNA: That's our company, yeah. It's just a little -- it's just the two of us, a little family company. So, when I need rock work done, especially chip work which I'm not very good at, I hire my husband because he's the best there is. And, when he has a client that needs rock work done and we want to be able to present that rock work on a map or to take that data and make an interpretation then that's my expertise.

PMB: Any crisis that affected your involvement in the oil sands? I'm just going to ask you a couple of things. And, the other one is: any notable figures that you encountered? And, of course, you already mentioned Jack Gallagher. So, first of all, any crises and of course you probably remember the National Energy Program.

HANNA: Yeah, I remember that well, $19.00 a barrel. Blech.

PMB: There was in the early 90s and really up to the end of the century, oil prices were fairly crappy; would you consider that a crisis?

HANNA: I don't actually. I look at that as a natural cyclical thing that happens. I've probably been through, I don't know, maybe four of those where the price is up, the price is down, the price is up, the price is down. I don't know why. It does that. And, just like in a human being's life, you can complain like crazy about when doors close on you. You can complain about that. You can whinge and whine, why me? Sometimes though, the blessing is that the door has closed and sometimes the blessing is that the door is opening for you. And, it's the same with hydrocarbon. If the price goes down, there are benefits to the whole because of that. When the price goes up, there are other benefits to other parts of the whole because of that. So, I try not to look at things in terms of us and them. I look at things like we're all us, right. Crisis, what crisis?

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PMB: This, I promise is my last question: any notable figures that you encountered and what would you like to say about them? We've all met great people in this business in this town.

HANNA: Man, oh man. I would have to think about that. As far as oils sands go Bob Mitchell currently at Conoco Phillips and my boss's boss Gord Lambert at Suncor are key fellas who are still alive as well as Peter Dickey who has passed on. These men are responsible for forming OSLI, the Oil Sands Leadership Initiative, which is a collaborative model between 7 of the big oil sands producers to share what they know and develop technology together, especially environmentally useful technology. OSLI lead to the formation of the 14 company strong COSIA which was recently formed and who are still working the bugs out on how they are going to work together. My boss Brian Doucette played a key leadership role in a collaborative effort to build a state of the art Water Research Centre up north. But, there are great people no matter where you go.

PMB: In the oil sands, oil sands other related people?

HANNA: I haven't been involved with the oil sands long enough to really say. It's only been a little over a year.

PMB: Fair enough.

HANNA: I'd have to think about it way harder than we have time for.

PMB: Is there anything you want to say?

HANNA: This has been a whole lot of fun.

PMB: Thank you very much for your time.

HANNA: I hope it's useful.

PMB: It's very useful. Thanks a lot.

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PMB: Maggie, you wanted to say one more thing?

HANNA: Yes, I did. The oil sands does get a bad rap globally. And, most of it is undeserved actually. If you look at it even from a CO_2 footprint, the oil sands CO_2 footprint is miniscule compared to the coal fired electricity generation of the Northeastern States. It is a fraction of a percent of what is going on there in terms of CO_2 production. If you look at it from Google Earth, let's say. You look down on it. You see tailings ponds; 50 square kilometres of tailings ponds. And, yet those are temporary. That is just part of the process. And, it's evolving and being perfected and new ways of doing things are being developed all the time that benefit the environment, for sure. So,

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the bottom line here is yes we're making a mess and we're also cleaning up the mess. An analogy is that the first big electrical generation wind turbines in the world never ever paid for themselves ever.

They were designed for 20 year life and they paid out in 25 years. It's the same thing. You start by doing it and learning about it and then doing it better and better. And, that is innovation in the oil sands. There are a whole lot of very heartful, very good, very smart people working on improving oil sands processes. Don't worry the mess is being cleaned up as we go. The amount of water that we use is recycled so many times we hardly take anything out of the river anymore.

PMB: I would add to that what about the cars that we drive?

HANNA: Yeah, that's it.

PMB: We talk about CO2 emissions, 80% comes out there.

HANNA: Yeah, that's true.

PMB: Of course, the other thing is heating the home and so on.

HANNA: That's right. There are hydrogen cars now. And, hydrogen can come from methane. We pluck four hydrogens off the carbon and we make hydrogen and CO_2. There is another new technology now. A company out in eastern Canada, they are called Atlantic Hydrogen who can make hydrogen from methane without emitting CO_2.

PMB: You can sequester that carbon as they are doing up at Shell's project.

HANNA: You can, but you can also make hydrogen from methane -- for hydro-treaters we need hydrogen. You can make hydrogen by sequestering the carbon in something called carbon black powder; no CO2! And, carbon black is fit for use for tires. Tires are 30% carbon black. You can recycle tires now with a pyrolic process that actually recovers the carbon black from a tire in a way that is useful to put it back into a tire again. So, this is the kind of thing that we're doing. Looking at the life cycle impact of things. We're going to be recycling all our tires up there that way. It's coming.

PMB: Thank you.

HANNA: You're welcome.

[END OF 2nd RECORDING]

PMB: I'm back with Maggie and I'm asking her about the Waste Inventory Project she's heading up.

HANNA: So, when OSLI was an entity, they had a group called the Technology Breakthrough Working Group (TBWG) who sponsored a project to categorize, and add up all of the waste volumes, produced by all of the companies, in all of the oil sands projects, in the entire Wood-

Buffalo Municipal District. And, I'm in charge of that project. It is an amazing thing. So, we have over 500 different waste streams, some are bigger, some are smaller. That waste data comes from three sources. It comes from the stuff that companies' track that they have to report to the government, that is public data. We have gathered that data on every oil company. Then there is the stuff that companies track, but they don't have to report to the government. A company has to voluntarily give us that data.

PMB: What material does that include?

HANNA: That includes things like tires, like batteries, like what you put in your landfill, process wastes like tailings and salt brines, and pet coke and asphaltenes, and construction wastes. And then, there is stuff that companies don't track, but you can make an educated guess on. So, things like food waste from a camp; nobody tracks that. The food waste goes into a landfill. But, the cooks put out X number of garbage bins every day that get taken away to the landfill. You know the size of a bin. You know how many days there are in a year. So, you can calculate about how much food waste there is.

If you can get the food waste from all of these companies and there is enough volume there, there might be an economic case to be made to say that we're not going to be filling up our precious landfills with this stuff. We're going to compost it over here. There might be a case to be made that regarding our bone yards. A bone yard is like the farmer's back 40 where he's got his Volvos and his old combine and takes parts out of there. We have our own boneyards. And, there was an instance just two months ago, a government official told me, that in the same week one company was looking for a small thickener and another company had a small thickener in their boneyard. But, that company had no use for it and so dismantled it for scrap, because they didn't know that the first company even needed one. What if, after we collect all this data, it makes sense to set up a Kijiji for boneyards. So, each of us publish the stuff that we have in our boneyards on the website, and sell it to each other. It's a way of using things that we make more fully. Another example is that when you build something up there, you always order more construction materials than you think you're going to need because it's so hard to get construction materials up there, the travel time, everything. So, you always order a little more than you need. So, what happens at the end of a construction project? All these mighty fine leftover materials either sit in the boneyard and get rained on and snowed on and degraded like insulation and like warping of wood or they go into the landfill just directly. What if we figured out, from adding up all the construction materials that are wasted in the oil sands area, that it made sense to put in a free store for construction materials? So, that any company can take their extra materials and put them in the free store and if they need anything that they don't have they can go to the free store and just take it out for free. So, it's just a big warehousing thing. The cost would be shared and the process effective for everybody.

PMB: Where does that stand? How long has this been going on to begin with?

HANNA: This project started in late 2011 and it was headed up by Mark Johnstone of Suncor until he retired in spring of 2012. The project was leaderless until Fall 2012. I took it over in the fall of

2012. We got the project back on track. And, we're hoping to have our data by the end of June of 2013 and at the very latest, by the end of August, 2013. Now, once we have that data and we know what the agglomerated totals are, then we start looking for the low-hanging fruit. So, phase two of this project is to do a half day workshop on each one of these waste streams. Let's call it batteries; batteries aren't supposed to go into the landfill, but of course, they do. How do you know how many batteries you've landfilled? Nobody counts them. But, supply chain had to order them, so you can get a pretty good number.

So, we've got a pretty good idea of the battery numbers. Let's just have a wild hallucination for a second. What if we find that in order to put in a battery recycling plant, you need a million batteries a year? What if we have a million and one? Then we might be able to spawn off another industry that uses a waste stream of ours as a feedstock. So, we're looking for by-products to change co-products, which actually have monetary value instead of a disposal cost. We're looking to provide waste streams as feed stocks for other industries. We're looking at ways to collaborate with each other. Another example, let's say there is a molybdenum catalyst that is a spent catalyst. And, a bunch of us have it but we hire different companies to come and pick that up and take it and recycle it. Well, what if we all hired the same company with one truck. They just came up and picked it up from all of us in one run and then took it to regenerate the molybdenum. Less CO_2 footprint, less cost, more efficiency.

So, there are savings to be had here, there are efficiencies to be had here. To take the idea even further, what if there could be enhanced collaboration between companies? What if so and so has a really big landfill and ours is filling up and we don't have our new one approved yet and we have all this stuff with no place to go? What if we could get another oil company to take our stuff into their landfill for a fee?

What if another company has a salt water disposal well and ours quits on us? Then what do you do? You say, "Hey neighbor-company down the road, you've got extra capacity in your disposal well. We know this from the waste inventory project. Would you take brine from us until we get our problem sorted out and charge us a fee?" It's about higher order of behaviour. Instead of behaving as competitors, behave as neighbors because we are in an industry together that is painted with one brush by the opinions of the press and the world. Oilsands companies are not competitors anyway, they are rivals. We used to be competitors when we bid against each other at land sale for mineral rights. But we don't do that anymore. All the land is bought up. We know who owns what. We don't compete on price of our product either; there is a world price for oil. We don't really even compete for talent because acquiring talent is more of an attraction exercise than a competitive one. But, there is a hangover habit of rivalry that the heads of these companies are still steeped in from the conventional oil days when you did compete at land sale for mineral rights. It is just a hangover. So, the beauty of COSIA is that those guys are going to get over themselves in COSIA, because as members of COSIA they have a mandate to share technology with each other to facilitate oilsands production in a more environmentally sound and responsible way.

[END OF RECORDING]

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