Watershed Systems
Hydrology - Geology - Soil Science

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Attached is my critique of the Excelaron (Mankins) Draft EIR from San Luis Obispo County (DRC 2009-00002; ED09-039).

Respectfully Submitted:

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Critique of Excelaron (Mankins) Project Public Draft EIR—

Hydrology and Geology Sections

July 30, 2011

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Executive Summary:

The geologic interpretations upon which the proposed Excelaron Joint Venture mineral development is based are naïve and misleading. Unlike most potential petroleum development sites, the subsurface geology of Mankins Ranch is not characterized by geologic structures that are closed to upward migration of fluids. Oil is not trapped by impermeable rocks deep underground, but has accumulated in leaky porous fractured rocks close to the surface. Most of the fluid in the broken and folded rocks is water. That water must be disposed of by pumping it back into the ground after the oil is separated from it. Available evidence indicates that the waste will flow back to the surface from the shallow injection wells over a period of a few decades and will contaminate local groundwater for many years.

The proposed pilot project site is but 160 acres within an adjacent 4982 acres that this Joint Venture proposes for Huasna area petroleum development. Water quality monitoring is proposed for only three existing agricultural wells on the Huasna Valley floor but potential groundwater contamination is likely over several square miles of private ranch and residential lands north and west of Huasna Valley. No groundwater quality monitoring is proposed for the lands most at risk. Private ranch lands are not exempt from groundwater pollution control requirements.

The proposed exploration and development is part of a larger and longer term Canadian investment effort. Much more thorough initial testing and feasibility analyses are recommended to establish the efficacy of the proposed injection well waste disposal, the truck transport of petroleum products along rural ranch roads, and proposed water quality monitoring standards. These efforts should precede approval of production wells and transport facilities.

Introduction:

Public concerns related to potential water resource impacts of petroleum exploration and development at the Mankins Ranch Excelaron Joint Venture site in southern San Luis Obispo County have been expressed by me and others following the announcement of potential petroleum production from this rural site in 1998. The present DEIR proposes to evaluate development of up to 12 oil wells in an old marginal petroleum exploration site west of the Huasna Creek Valley.

This review will look at hydrologic and geologic aspects of the proposed exploration and development of the Mankins Ranch site east of Arroyo Grande. Despite a prior attempt to promote petroleum development in this site based on a Mitigated Negative Declaration, local landowners raised geologic and hydrologic issues that merited development of a full EIR. The May, 2011, draft EIR prepared by Marine Research Specialists devotes approximately 450 pages to assessment of environmental impacts as required by the California Environmental Quality Act (CEQA). Yet only 11 percent or 50 pages address geology or water resource issues. Those issues are critical to evaluation of potential impacts of the proposed project.

Setting for On-Site Impacts:

The authors of the Excelaron EIR have attempted to constrain the geographic area of concern for potential water resource impacts to an area of approximately one square mile as shown the Cleath-Harris Geologists' Figure 1 of July 21, 2009 (see figure 1 at end of this report). This map and study are cited in the EIR (Section 4.14) and appear to be the primary reference used by the EIR authors. The report is unpublished but available on the San Luis Obispo County Planning website. An older basic geologic reference paper published in 1967[1] was simplified and interpreted by Cleath-Harris for their July, 2009 submission that became the primary basis for the Water Resource chapter of the EIR.

Simplification of complex geologic interpretations is valuable in the EIR process. However, the Cleath-Harris approach may be overly simplified. This report (hereafter called *Excelaron water*) which is the basis of the water resource section of this EIR does not clearly justify the small geographic area of potential hydrologic impacts. The surface geographic area leased for the 12 potential petroleum exploration and production wells is about 160 acres (EIR § 4.4.1.1). The EIR purports to assess potential water quality issues on 7 adjacent 40-acre private parcels but the red line on Figure 1 circumscribes more like 640 acres. It is unclear how Cleath-Harris dismissed need for potential consideration of the other 200 acres circumscribed in their Figure 1. It is also unclear why the 2009 *Appendix F Excelaron water impacts final* document (its page 2) states that the *"project site is located on 260 acres".* In a December, 2010, United Hunter Oil (UHO) press release they state: "*UHO owns 65% of the 160 acre project area of the Huasna field through the Excelaron Joint Venture. On the remainder of the field area UHO holds variable interests and has verbal agreements on the remaining interests with the other mineral rights owners in which they concur to allow leasing of those interests once the first phase of development is permitted by the regulatory authorities"* http://www.newswire.ca/en/releases/archive/December2010/20/c6622.html . Thus, the

[1] Hall, Clarence A., and Charles E. Corbato, 1967, Stratigraphy and Structure of Mesozoic and Cenozoic Rocks, Nipomo Quadrangle, Southern Coast Ranges, California. Geol. Soc. America Bull. v. 78, p. 559-582.

ownership and ultimate scope of the project remains ambiguous. This EIR only covers 12 wells directionally drilled from 160 surface acres, although the below-ground exploration and treatment zone may be on the order of 640 acres and the areas of verbal agreements with owners are completely unknown[2]. If mineral rights have been separated from surface rights; that too is unknown.

We cannot determine how Cleath-Harris justified consideration of only the area outlined in their Figure 1. They state *that "Of the parcels shown, seven 40-acre parcels on the southwest side of the project are within the potential impact area and are not owned by Mankins or Porter family members (the proposed project and access to the project are on the Mankins and Porter properties)"* (p. 4 *Excelaron water*). Indeed, further checking confirms that much of the remainder of the Figure 1 area is owned by Mankins or Porter families. But does this exclusion imply that risk of water supply damage is acceptable to all parties? Is it the intention of this exclusion to imply that damage to potable aquifers on Porter and Mankins properties cannot extend beyond their parcel boundaries? Does not the Regional Water Quality Control Board have responsibility for groundwater pollution on both public and private properties under the Porter-Cologne Water Quality Control Act? There is no justification for ignoring potential groundwater contamination over a much wider impact area.

Potential for groundwater contamination:

Cleath-Harris present information on what they term the "Groundwater Impact Area". This is a useful concept but must be based on sound geologic information and in this case is misleading. The Cleath-Harris *Excelaron water* report, on pp. 3-4, discusses their opinions that any effects of petroleum contamination of regional groundwater would remain very limited in geographic extent. They state:

> "*Outside of the project property, on the flanks of the anticline, the siltstone and sandstone beds identified as Tmp_3 dip beneath younger siliceous siltstone and claystone beds (unit Tmp_{5b} on Figure 2). Both of these units have fine-grained strata that neither store nor transmit water. Test holes have been drilled into these units that have been dry. No springs are known to come out of the Tmp_3 unit and only minor springs are found in the Tmp_{5b} unit. Because the Tmp_3 siltstone and the immediately overlying unit are not permeable, impacts from project activities would be confined to any sandstone beds within the Tmp_3 and geologic units underlying the Tmp_3.*"

In essence, the argument against potential contamination rests on the assumption that the subsurface geologic units in this part of the Meridian anticline are unfractured, uniform and lithologically consistent. This gross simplification is presented in Cleath-Harris' Figure 3. *Cross-section of Meridian Anticline.* Figure 3 is a "cartoon" representation of over 7000 vertical feet of layer-cake stratigraphy, based primarily on one deep well. This geologic simplification is misleading and cannot be used to justify an assumption that each geologic unit is laterally consistent, unfractured, and has consistent porosity and permeability. In fact, the applicants admit that they hope to extract oil from fracture porosity (Vesta Capital, 2010). A stratigraphic section inferred from only a few wells can be used by geologists to explain and predict geologic units to

[2] A February United Hunter Oil press release states that "UHO is in advanced negotiations to lease an additional adjacent 4982 acres".

be encountered in adjacent wells, but cannot be used to rule out fracture porosity, lateral changes in bedrock permeability (facies changes), and other normal geologic changes in rock units that represent either original depositional variations in sedimentary rocks or post-depositional changes associated with ±60 million years of local and regional folding and faulting. Folding of the Meridian Anticline to its present 60-degree structural dips has occurred as this block of crust is wrenched laterally between the San Andreas Fault and coastal California (Hall, 1981).

The 1967 paper by Clarence Hall and Charles Corbato shows some faulting parallel to the primary West Huasna Fault within the Meridian Anticline block, but the cross-section chosen by Cleath-Harris lies south of the similar, but more realistic, 1967 section B-B' that is interpreted in Hall's paper. If there were no pathways for leakage of oil and gas to the surface, past attempts at production of economic quantities of crude oil might have been successful and oil and tar seeps would not be so widespread over the region. The tar seeps may be located along faults. The geologic map presented by Cleath-Harris as their Figure 2 cannot be interpreted to indicate that there is no faulting in the exploration area of the Meridian anticline. The Hall-Corbato cross section crossed major offset geologic rock contacts that could not be seen at the Cleath-Harris cross section.

The *Excelaron water* report refers to an interpretation of the Hall-Corbato compendium that was used by Cleath-Harris to develop their cross-section Figure 3. This uncited work is attributed to Katherman Exploration and may have been developed by Charles Katherman of Santa Maria. Again, his interpretation appears to be one focused on regional stratigraphy of bedrock units only and not on potential structural, fracture or other inhomogeneities that control permeability. We concur with the Cleath-Harris assumption that the active West Huasna fault zone should limit westward possible contamination of water-bearing shallow Santa Margarita Formation sandstone and the poorly consolidated sand units that serve as local aquifers. But we do not understand how one can dismiss potential contamination east of that fault zone, particularly to the south and north of the oil development area along the axis of the anticline. One cannot assume that the Tmp_{5b} unit or other units of the Phoenix member of the Santa Margarita Formation are impermeable simply based on some of their basic silty clay lithologies. Fracture permeability may be independent of the rock type and the Tim O'Leary watercourse that drains the area east of the west Huasna Fault and south of the development site may be subject to contamination through fracture permeability. Absence of perennial springs based on the local knowledge of lifelong resident Lester Mankins does not preclude seasonal surface or perennial subsurface water contamination.

The distance between the nearest proposed drilling pad and the surface watercourse in Tim O'Leary canyon is less than 2600 feet. The distance from the nearest drill pad due south to the south boundary of the "Groundwater Impact Area" in Tim O'Leary canyon is about 2700 feet. Assuming a rate of migration of 1-foot per day for contaminants, impacts might occur to that waterway or to wells in its vicinity in as little 7 to 10 years, or longer if water movement is slower. The EIR only purports to consider potential impacts to the 7 40-acre parcels 085-271-021 through -025, and 048-151-15 and 048-151-044. These are to be mitigated through unspecified monitoring, but for most of the parcels, by the time petroleum hydrocarbons are detected, it is too late to reverse the contamination of the aquifers. This situation is not like those near leaking gasoline tanks in cities. If the Excelaron monitoring well does not intersect the zone or feature that provides an avenue for migration of fluids, a nearby well may show no contamination while a more distant well may reveal hydrocarbons beginning a decade after the pollutants are released.

Proposed Mitigations are not effective:

The EIR assures the public that mitigation measures will protect water supplies and water quality. Those mitigations are listed on p 4.14-14 and in tabular form at §4.14-7. Those mitigation measures are not at all adequate. The mitigation plan relies upon the Central Coast Regional Water Quality Control Board to review "quarterly testing of wells for hydrocarbons and other compounds that would be expected from oil production operations." It states that "testing should continue for at least three years after termination of any oil production activities." (Mitigation WR.3-3(b))

First, the mitigations do not specify which wells are to be tested, nor their depths and other characteristics. The supplemental material supplied by Timothy Cleath to San Luis Obispo County and posted on the Mankins/Excelaron County website discusses County-requested water quality monitoring[3]. That letter states:

> *"Currently, we are discussing the possibility of sampling and testing the well that is closest to the project site with it's property owner (APN 085-271-025). This well has a similar electrical conductivity level to the water in the oil seep pond. However, until such time as we can reach an agreement with this property owner no information is available. Additionally, we have sampled and tested another well slightly further to the west (APN 085-271-024). We were allowed to sample this other well and have had that well's water tested. The results of this other well's water test also is attached to this letter. As with the seep pond water, no TPH (gasoline) or BTEX were detected in the water well water."*

APN 085-271-025 is at 7881 O'Leary Canyon Way immediately south of the southernmost initial exploratory drill pad. APN 085-271-024 is immediately west of the westernmost proposed drill pad at 7222 Cougar Ridge Road (see Cleath-Harris *Excelaron water*, Figure 1). While these are logical and important sites to monitor, they are not sufficient in number, may not be of adequate depth, and may interfere with domestic water uses on those adjacent parcels. If landowners are unsure if they want their wells sampled quarterly, it may be necessary for Excelaron to drill additional water wells for monitoring purposes only. San Luis Obispo County <u>does</u> have access to required well-driller's records and shares responsibility with the Regional Water Quality Control Board to insure continuing potability of domestic wells. The County could evaluate its well-records while maintaining confidentiality and could therefore assess suitability of private wells to be indicators of regional groundwater contamination.

More extensive testing of wells father from the proposed drill pads should also be undertaken. The two immediately adjacent private property parcels may be drawing water from too high in the stratigraphic column to show contamination in a period of about a decade. Additional sampling must include lower-elevation parcels such as those near the bottom of Tim O'Leary Canyon at 82750 O'Leary and 7990 Cougar Ridge. Added sampling of the spring identified on parcel 085-271-22 and on 085-271-06 is recommended. Sampling on the Mankins Ranch properties should not be excluded,

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[3] Cleath-Harris Geologists, Sept 21, 2009 Response to Additional information Request for Excelaron Project (DRC2009-00002)

particularly seeps, springs and wells at topographically low points along the trend of the anticline north of the drilling sites, and on the Porter Ranch hillside along the west side of Huasna Valley.

The DEIR only proposes that Excelaron will install a network of three groundwater monitoring wells at the western edge of the Huasna Valley Groundwater Basin closest to the project site. That will help to evaluate groundwater pollution in the event of a spill in the watershed of the 160-acre project site but will do nothing to protect or alert landowners or water users in Tim O'Leary Canyon or the lower Twitchell Reservoir area and beyond.

Second, the testing must focus on appropriate potential pollutants. The Cleath-Harris September 21, 2009 response to the County clearly indicates that there is confusion about appropriate testing by the County and possibly by Cleath-Harris. In response to the County request, Cleath-Harris submitted water quality monitoring results for samples taken from the Shively Well at 7222 Cougar Ridge Road and from an existing seep near the proposed shipping site. However, the analyses were only for TPH - Total Petroleum Hydrocarbons $_{(gasoline)}$, and BTEX, not for crude oil high-molecular-weight residues. Obviously, there is no history of gasoline storage in underground storage tanks (USTs) or above ground spills at either site so TPH $_{(gasoline)}$ analyses should come out as "non-detect", which they did.

Analysis for TPH $_{(gasoline)}$ is commonly conducted in suburban areas where old underground storage tanks may have leaked for years. Even though "TPH" refers to "Total Petroleum Hydrocarbons" the various testing methods used by most labs are not intended to look for residual components of crude oil, especially the forms of highly resistant viscous low-volatility residual long-chain hydrocarbon crude oil that characterizes the known seeps and wells on the Meridian Anticline. Neither TPH $_{gasoline}$ nor TPH $_{diesel}$ test procedures look for the long-chain, less-volatile components of unrefined petroleum. Further, the testing widely conducted for USTs will often simply return "non-detect" results because of sample handling or procedural flaws in the chain-of-custody and lab analyses. An excellent but rather devastating review of the various laboratory procedures is available on-line at: www.nature.nps.gov/hazardssafety/toxic/tph.pdf. This federal study concludes that traditional laboratory analyses designed for use with underground storage of refined products and even some of those approved by EPA are often flawed and ineffective for their intended urban use, and are totally inappropriate for use in a potential oil field.

An analysis of TPH and petroleum hydrocarbons from the standpoint of public health is available on-line from the US Department of Health and Human Services' Agency for Toxic Substances and Disease Registry (ATSDR). § 3.3 of the report at: www.atsdr.cdc.gov/ToxProfiles/tp123-c3.pdf states:
"The term "total petroleum hydrocarbons" (TPH) is generally used to describe the measurable amount of petroleum-based hydrocarbons in the environment; and thus the TPH information obtained depends on the analytical method used. One of the difficulties with TPH analysis is that the scope of the methods varies greatly. Some methods are nonspecific while others provide results for hydrocarbons in a boiling point range. Interpretation of analytical results requires an understanding of how the determination was made."

Most petroleum geologists working with a drilling team scan the cuttings with an old-fashioned black light or use simple spot chemical tests to detect presence or absence of hydrocarbons. To assess oil-field water-pollution risks, BTEX is a more appropriate focus for analysis, but still relies on detection of common products of *refined* petroleum. BTEX refers to benzene, toluene, xylene, and ethylbenzene. While some of these hydrocarbons exist in crude oil, the test procedures were designed for refinery products, not heavy viscous crude oil. Thus, the testing done by Cleath-Harris and apparently accepted by San Luis Obispo County is completely inappropriate to assess taste, odor, and potential hazardous crude oil components.

The subsequent chemical analyses of well-water conducted by the dEIR preparation firm of *Marine Research Specialists* and by the Huasna Valley Association as presented in dEIR Appendix H are all useful and serve to establish a baseline against which to measure future conditions. However, most of these analyses continue to focus on constituents that may not reflect oily saline components of reinjected oilfield water or hot water or steam-driven remobilized tarry residual petroleum. The single exception was the Oct 6, 2010 detailed “fuel fingerprinting” analyses of wells WHO-1 and WHO-2 using EPA method 8015 by BC Laboratories. Those analyses were still directed toward *fuels*, and not petroleum residues, and are only sampled from shallower wells in the Huasna Valley floor. Contamination of those wells sites would most likely arise from seasonal discharge or spills into the watercourse on the Mankins Ranch that flows eastward past the proposed shipping site. Well WHO-3 is located closest to that watercourse and did show petroleum hydrocarbons in a 2009 sampling. That well was not able to be resampled because of problems with purging (App. H, pp. H-2 and H-3) but it seems unlikely that the condition of the well casing alone could result in the observed 2009 contamination by petroleum residues.

The well-driller’s reports for the Allen family wells that are presented in Appendix H note “H/S” which is probably a drillers’ indication of hydrocarbon smell or sulfur smell. Allen well #2 is located directly on the Meridian Anticline north of the proposed Excelaron site and would be expected to show traces of oil seep contamination in the form of sulfur compounds and odors.

Third, monitoring needs to continue for several decades if the oil-field is put into production. While risks are highest during steam or hot water injection, and decline rapidly as the tarry residuals congeal and permeability decreases, the water-borne less-viscous components may migrate for decades. Because we do not know how much fluid is to be reinjected as water to drive oil or as waste, nor the depths of those two separate injection procedures, it is difficult to predict the duration of monitoring for groundwater pollution. Presumably, deep saline-water disposal wells can be designed and tested to assure that they do not risk creating or intersecting fracture permeability zones. But the steam/water drive may have to be shallow enough to risk regional groundwater contamination (Butler, 1997). On cannot assume that three-years of monitoring will be at all adequate.

Injection Well(s):

Hot Water Drive and *Produced Water Disposal* are both proposed. Appendix A of the dEIR provides some of the design engineering criteria that are proposed for the waste and hot-water drive functions of the injection wells. The location is shown only for one waste disposal well (Appendix A, Sheet A-2). Propane consumption for water heating is proposed to be 1389 gallons per day. This is substantial. Even the cost of this propane is over $5000 per day and it must all be trucked to the site and transferred to local storage. The waste injection electric motors are estimated to require a continuous electrical load of 74.6 kilowatt while that for the hot water injection pumps require and added 37.3 kW of continuous load. Depths and locations of the injection wells are not yet known or represented in any of the layout drawings (EIR App A).

We are told that "The majority of the produced water will be re-injected into the original formation at one disposal well located at the Shipping Site" (dEIR 14.14-14). The next statement is "The Huasna Valley groundwater basin is approximately 300 feet below the ground surface. The extracted production water would be re injected into the oil formation located approximately 3000 feet below the ground surface". This *non-sequitur* is presumably intended to imply that if you inject water into the ground 3000 feet below the surface, it will not come back to the surface. While this might be true for a short term period of a few years, ultimately an overpressured area must equalize by leaking towards the surface. Vertical permeability must exist, based on the widespread petroleum seeps that originate at greater depth. This is not your typical textbook oil-field. In fact, the "original formation" of origin for the oil is the Monterey Formation while the production is proposed to be from the overlying Santa Margarita Formation. Usually, waste water is pumped into the geologic units from which the oil is being withdrawn. The dEIR is not clear on this important issue.

Even the Cleath-Harris Figure 3 cartoon stratigraphic section shows that a 1-mile-wide area at the top of the anticline encompasses "*An area where water wells can be drilled to the potential water/oil bearing zones at less than 1000 feet*". This figure may even partly explain the illogical and apparently arbitrary delimitation of the "Limits of potential groundwater impacts" red line on Cleath-Harris Figure 1. They may have simply assumed that a 1000-foot practical limit on depth of water supply wells would have to be protected from contamination by the proposed project. But this assumes that there is no vertical migration of fluids from waste-water injection. Waste-water injection is a common practice in many well fields but not in mixed residential areas with domestic water wells or where natural gas may be driven into buildings or surface infrastructure by "excessive" injection pressure through vertical permeability.

The State of California Department of Oil, Gas and Geothermal Resources (DOGGR) regulate injection wells in oil fields and even in urban environments. The regulations are in-part necessary to comply with federal regulations to protect water quality. A basic problem is that the DOGGR regulations are primarily based on the reasonable assumption that if there was a natural trap for hydrocarbons such as oil and gas, that same geologic structure should also isolate and protect shallower groundwater aquifers from deeper injection zones. In this case the Monterey Formation shale beds are believed to be source rocks for the oil in the Huasna field (DOGGR, 1992, pp. 182-185). However, in the old LaVoie-Hadley area that is the focus of the proposed Excelaron activities, that oil had partly migrated up into the more permeable Santa Margarita sandstone and siltstone units, from which it was able to leak to the surface (*op cit*, p. 184). Thus, the basic assumption of oil-field integrity upon which Class II disposal wells are based, may not prevail at this site.

Operators of Class II injection wells (used for oil-field brines and wastes) must file for a permit with the DOGGR. Before a permit is issued, the proposed injection project is studied by Division engineers and reviewed by the appropriate Regional Water Quality Control Board. Division engineers evaluate the geologic and engineering information, solicit public comments, and hold a public hearing, if necessary. Injection project permits include many conditions, such as approved injection zones, allowable injection pressures, and testing requirements. These testing requirements can assess integrity of the proposed injection sites by looking at pressure variations through time if one assumes that short term measurements reflect longer-term stability. But where the petroleum reservoir rocks are not tightly capped by a geologic cap-rock structure or where they are so shallow and fractured that the very act of injection increases fracture porosity, long-term integrity is in doubt.

Injection pressure regulation and testing is specified by California Code of Regulation rules as briefly mentioned at DEIR p 4.8-25, Mitigation GR.6-1: That Code statue includes the following two sub-sections:

(i) To determine the maximum allowable surface injection pressure, a step-rate test shall be conducted prior to sustained liquid injection. Test pressure shall be from hydrostatic to the pressure required to fracture the injection zone or the proposed injection pressure, whichever occurs first. Maximum allowable surface injection pressure shall be less than the fracture pressure. The appropriate district office shall be notified prior to conducting the test so that it may be witnessed by a Division inspector. The district deputy may waive or modify the requirement for a step-rate test if he or she determines that surface injection pressure for a particular well will be maintained considerably below the estimated pressure required to fracture the zone of injection.

(j) A mechanical integrity test (MIT) must be performed on all injection wells to ensure the injected fluid is confined to the approved zone or zones. An MIT shall consist of a two-part demonstration as provided in subsections (j)(1) and (2).

Here again the problem is that one cannot expect to inject into the existing reservoir rocks [Tmp_3 – Phoenix Member of the Santa Margarita Formation] because they are uncapped (see Cleath-Harris Figs. 2 & 3) and would leak out, so the logical alternative is to inject deeper into the Monterey Formation (Tmm_3) which is in fact the source rock from which the petroleum fluids have already leaked upward. Due to existing fracture porosity and permeability in the Monterey rocks in the anticline, it is doubtful if a stable injection pressure can be established over a long enough time to safety dispose of all the waste water (Shumacher, 1999).

Mitigation GR.6-2 (dEIR 4.8-25) requires geologic information that does not exist or that is so imaginatively interpreted in the Excelaron (United Hunter Oil) business plan of 2010 (Vesta Capital, pp 9-15) that it is not geologically realistic. The DOGGR requirements are clearly not intended to evaluate feasibility of injection into uncapped shallow Santa Margarita Formation aquifers.

I**nduced Seismicity** is a very real hazard associated injection wells. Figure 2 (at the end of this report) is an aerial photo upon which the approximate location of the recent June 20, 2011 earthquake is plotted as is the proposed injection well at the Shipping Site. Injection wells are known to trigger earthquakes by changing the pressure, lubrication, and thermal properties of stressed subsurface rocks. In this case, the focal depth of the recent earthquake was very shallow, less than 4000 feet, and at the primary zone where both production and injection may most likely occur.

A large technical literature is available on oil-field induced seismicity, most often associated with disposal of co-produced water and other oil-field wastes. The following bibliography was compiled in 2007: http://www.nyx.net/~dcypser/induceq/pis.html . Early examples of induced seismicity included the damaging earthquakes in the Wilmington oil field of Southern California. Those seismic events proved to be the result of extraction of fluids without replacement, resulting in subsidence. Contemporary practices that re-inject oil field wastes during the time that materials are being extracted are believed to offset this particular triggering mechanism. At the Huasna Excelaron Joint-Venture site the waste water volumes may represent 90 percent or more of the total volume of pumped fluids, thus suggesting that subsidence would not be a significant problem if they are all immediately re-injected into the production zones. But pressure variations throughout the proposed production and disposal zones may still be great enough to contribute to reduced compressive strength in local areas, resulting in spontaneous release of stored energy in the form of induced seismicity.

Seismic activity is not necessarily damaging. The June magnitude 2.7 and subsequent July 1 M1.1 aftershock along the west Huasna fault zone about 1 mile from the proposed Excelaron project site may have been simply the result a wetter-than-normal winter rainfall volume that loaded the shallow fault zone by recharging the shallow groundwater zone. Similarly, waste water injection may help relieve accumulated stress in the fault zone and adjacent anticline. But this proposed reactivated oil field is now in a rural residential area and proposed activities may induce liability for property damage as well as small earthquakes.

***Road Stability*:**

Concerns about road stability during winter rain periods were brought up by residents and by me (Curry, 2009) in prior EIR scoping documents. The current dEIR proposes to meet these concerns with a 4-inch gravel aggregate base, or a depth specified by San Luis Obispo County Public Works, along graveled areas of Mankins Ranch and Porter Ranch roads (Mitigation T.2-1, dEIR p 4.13-19). Although we cannot anticipate future actions of the County Public Works Department, we can estimate that the subsoils below these existing ranch roads will, in many places, require more than 4-inches of engineered fill.

In fact, the ranch roads along the proposed revised haul route are subject to liquefaction. The Salinas Loam soil unit and the creekside alluvium of Huasna Creek itself, where the proposed haul route is now located, is very poorly drained and slow to percolate seasonal water and is frequently saturated with high local groundwater (USDA, 2008). While seismic hazards may not be limiting, the weight of trucks passing over dirt fill on these ranch road routes is sufficient to mire local pickup trucks. It is reported by local ranchers that similar liquefaction occurs on the Porter Ranch Road. Excelaron proposes to lay fill on these ranch roads to upgrade them for heavy haul trucks. These details have not been worked out for the present version of the proposed Excelaron dEIR, nor has the cost and sources of fill necessary to upgrade the roads to carry heavy loads and resist liquefaction been identified. An EIR should develop better information on potential liquefaction hazards along the Huasna Valley floor. In our 2009 response to the proposed Excelaron County CUP we outlined and mapped some of the areas where soil mapping indicates potential serious limitations for product hauling, equipment delivery to the drill sites, and delivery of supplies such as propane gas.

The dEIR presents information that attempts to address restrictions on use of the Porter Ranch Road for heavy trucks when the Twitchell Reservoir levels are high and water is backed up to flood lower Huasna Creek (dEIR 4.13-18). A set of mitigations (T.2-7 *e, f, & g*) are designed to restrict use of that road when the Twitchell Reservoir levels are high enough to potentially saturate the road bed or its foundations. A reservoir water level of 595 feet was chosen for the critical level above which truck traffic must cease and the well-field must be temporarily shut down and tanks drained. Between 590 feet and 595 feet, use of the road is to subject to inspection by the applicant to insure suitability for heavy trucks.

The USGS topographic maps (Nipomo, 1965; Huasna Peak, 1974) show backwater flooding in Huasna Valley at differing elevations. The Nipomo Quadrangle shows it at 687 feet, while the later 1974 update to Huasna Peak Quadrangle brings it down to the spillway elevation of 652 feet. In fact, the dam operations manual states that it is 651.5 feet (Twitchell Project Manual, 2010) and demonstrates that the sediment accumulations in the reservoir reached the dam by 1996 and had aggraded back upstream well before that. The elevation of the dam spillway does NOT determine the lower bound on water levels adjacent to Porter Ranch Road because a gradient must be established to carry water and sediment downstream during floods.

The dEIR authors determined that Twitchell Reservoir reached a water surface elevation of 599 feet (the elevation where flooding covers 135 or more feet of Porter Ranch Road) on 8 separate years since 1962 (dEIR 4.13-18). The authors' are to be commended for conducting this analysis but it cannot be used to evaluate probability of future use of the Porter Ranch Road. The plot of elevation versus capacity for various survey periods for the reservoir (p 24 of the 2010 Project Manual) shows that the current 60,000 acre-feet reservoir capacity (for a <u>reservoir elevation</u> of 599 feet) has decreased some 20,000 ac-feet since 1981. That is a 33 percent capacity loss due to sediment accumulations from the Cuyama River in 29 years at that critical elevation. There have in fact been 9 separate years of published reservoir level measurements between July 1961 and December 2000 with that limiting reservoir level, and they are becoming more frequent as the Huasna Creek delta builds up in the reservoir. California Data Exchange reservoir level data are not available after January, 2000.

We conclude that the published month-end data indicate that the proposed mitigations for avoiding saturation of the road bed for the Porter Ranch Road will limit shipping via that route every other year, with three-month periods on non-use in wet years. This will have significant impacts on proposed petroleum production that have not been discussed in the dEIR.

Recommended Further Studies:

Possibilities of groundwater contamination could be reduced by drilling one or more disposal wells, logging them, and testing them under pressure before drilling any wells designed primarily for oil recovery. Standard DOGGR disposal well test results and information could then be developed before committing to full site development. Such a well or wells near the shipping site would then permit monitoring groundwater close to that disposal site and permit establishment of an appropriate suite of analytical water quality testing procedures and analytes focused on the most probable components of waste production water.

Engineering testing of overexcavated and artificially saturated road subgrade soils should be seriously considered along the Porter Ranch Road where it is subject to saturation by the increasing elevations of backwater from the Huasna Creek delta in Twitchell Reservoir. Relying on San Luis Obispo County for specifications of bearing strength, plasticity index, and crushed rock drainage layer thickness may be imprudent when the proposed large truck traffic is considered in light of the potential economic impacts of interruption of the Joint Venture project. Given the absence of a long-term plan to restore Twitchell Reservoir capacity, the EIR should require an engineering plan that evaluates the impacts of prolonged closure of the Porter Ranch Road during years of flood.

Conclusions:

This brief report covers hydrological; and geological risk issues only. The primary concern is that the dEIR for the Excelaron Joint Project at the Huasna Oil Field is based on incomplete and erroneous geologic information that does not evaluate accurately the stratigraphy and tectonic status of the residual petroleum that Excelaron hopes to recover. Because the geologic conditions that have led to residual oil deposits are greatly oversimplified in both the dEIR and its foundation documents, the project proponents have been able to pose an unrealistic and fundamentally hazardous set of exploration, potential production, and waste disposal operations.

The most dangerous oversimplification is that of stratigraphic continuity and impermeability of capping geologic units in the Santa Margarita Formation. Despite clear field evidence to the contrary, the project proponents and their consultants insist that the lack of surface springs in areas mapped as the Phoenix member of the Santa Margarita sandstone (Tmp_5) imply that it is impermeable and unfractured. In fact, precisely to the contrary, Tmp_3 must be open to infiltration of rainwater (and exfiltration of upward-percolating hydrocarbon fluids). The Excelaron consultants Cleath/Harris state that "*the oil-bearing strata are below the impermeable siltstone/shale beds within the basal Phoenix member of the Santa Margarita Formation*". This faulty belief is the basis for most of the water quality mitigations. The basal Phoenix member is Tmp3 and the Cleath-Harris study concludes that "*No springs are known to come out of the* Tmp_3 *unit and only minor springs are found in the* Tmp_{5b} *unit. Because the* Tmp_3 *siltstone and the immediately overlying unit are not permeable, impacts from project activities would be confined to sandstone beds within the* Tmp_3 *and geologic units underlying the* Tmp_3".

But the Tmp_3 unit ***is*** the surface unit in the project area (see Cleath-Harris, Figure 2). It is the top of a hill. Of course there are no springs on the top of a hill. There are known oil and tar seeps in that surface geologic unit. That geologic unit may be less permeable siltstone, but it is only about 200 feet thick and is at the crest of an anticline with locally mapped dips of 30-50 degrees. Such a site cannot be considered "impermeable" or "not permeable", especially with several hundred feet of topographic relief and immediately adjacent to the West Huasna Fault.

This report does not raise issues of potential poorly engineered oil-well development such as leaking well casings, leaking transfer facilities, or problems with separation of potential products from wastes. It is assumed that DOGGR regulations and oversight are 100 percent effective even though statistical records from the past few years reveal some releases of wastes to shallow aquifers and oil development site spills. It does raise issues with the adequacy of available information on the continuity and stability of waste disposal stratigraphic traps that will be needed to isolate saline oilfield wastes from groundwater aquifers in perpetuity in this tectonically active site. It also raises regulatory issues around potential contamination of shallow aquifers on private lands that may be under lease agreements but are still protected under federal and state laws.

This report further questions the adequacy of proposed mitigations to protect local Santa Margarita and Huasna Valley alluvial aquifers, and questions the efficacy of three proposed Huasna Valley shallow monitoring wells to protect regional Santa Margarita Formation surface aquifers.

Robert R. Curry

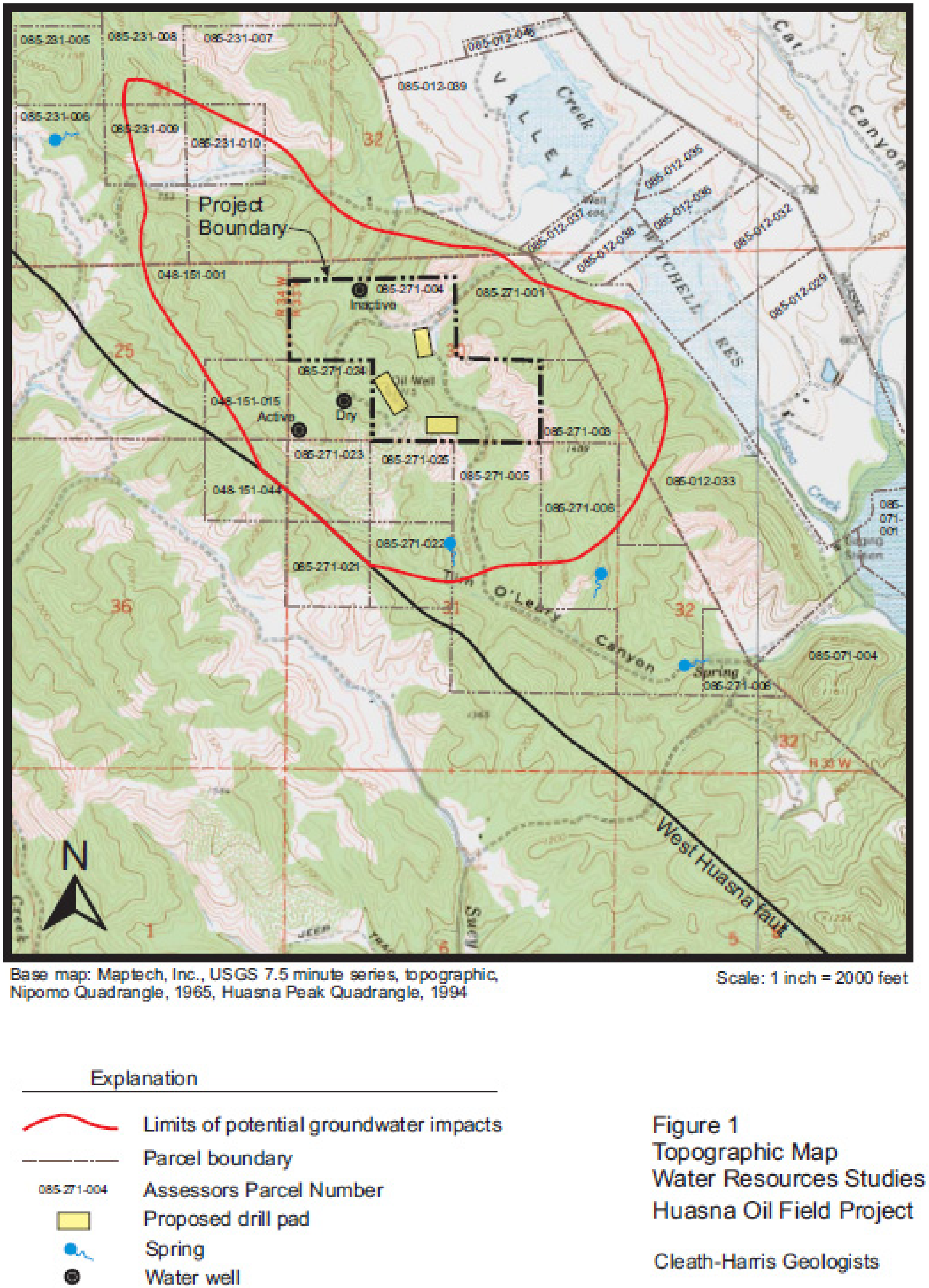

Figure 1: Cleath-Harris, 2009, Figure 1, Water Resource Impact Study for the proposed Huasna Oil Field project, Huasna Valley, California following page 2 of that July 21, 2009 study. Scale is not accurate

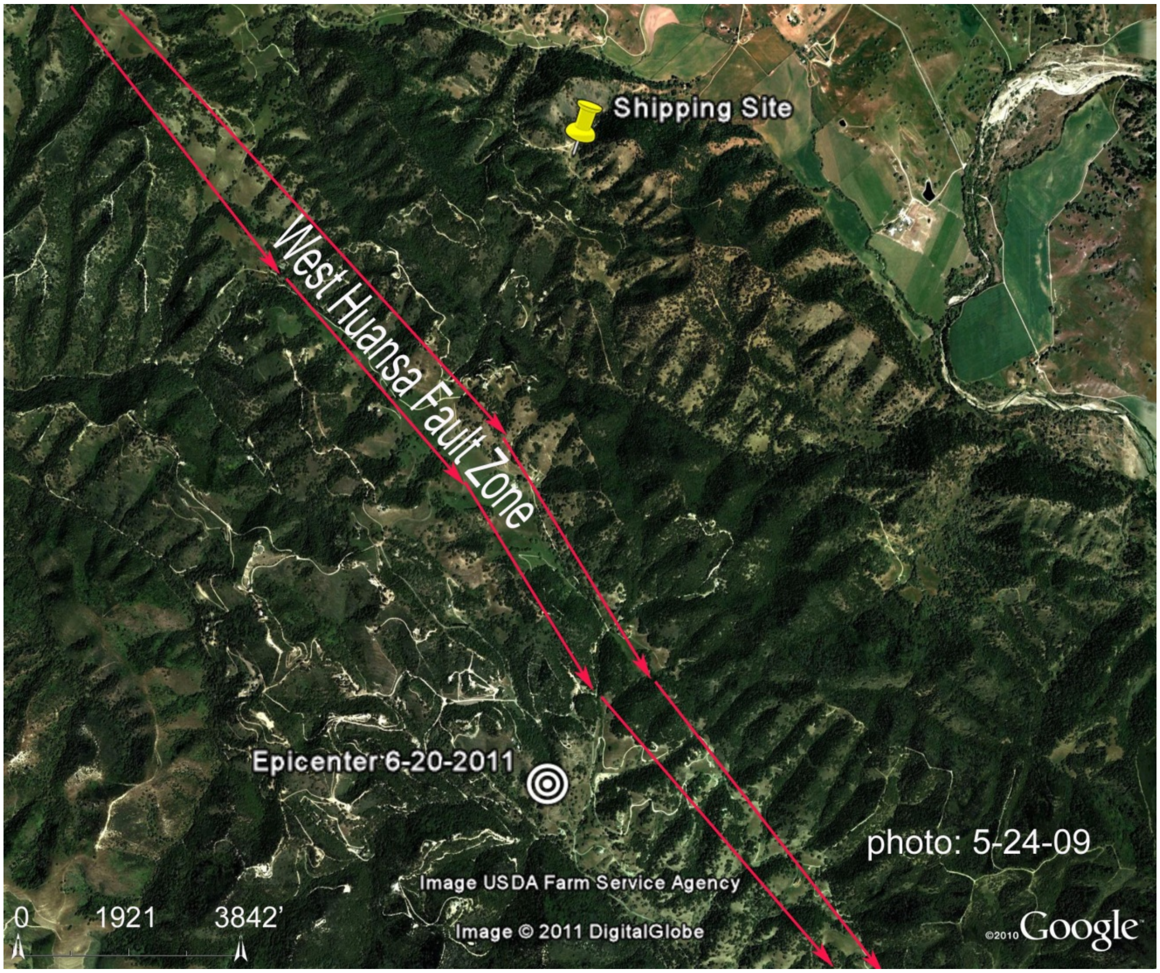

Figure 2. Google Earth Pro photo showing location of proposed Shipping Site in relationship to the approximate alignment of the West Huasna Fault Zone (red lines) and the location of the June 20, 2011 7:07 AM Magnitude 2.7 epicenter at only 1.1 km depth (bullseye). Fault Zone location is approximate based on Hall, 1978 & 1981; and Department of Water Resources, California, 2002, Plate 2.

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