Management of Subsurface Landfill Fires at the Closed Kailua-Kona Landfill

Kailua-Kona, Island of Hawaii, Hawaii

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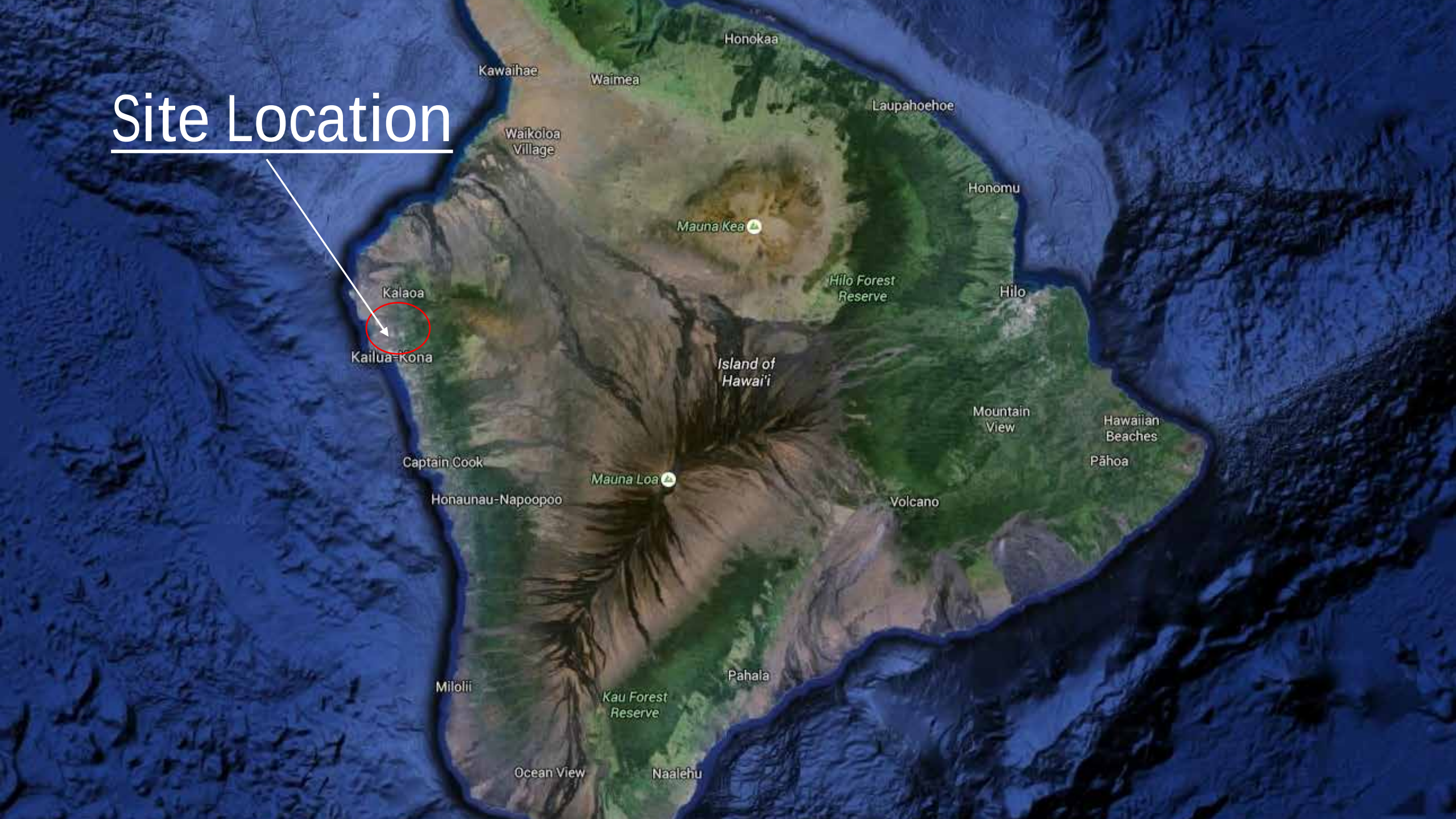
Site Background:

- The Closed Kailua-Kona Landfill is located on the west side of the Big Island of Hawaii, approximately two miles north of Kailua Town.
- The site has been used as an open dump and/or permitted MSW landfill since the 1960s.
- The landfill is unlined, occupies approximately 30 acres and is located on an A'a lava flow. The site likely has a lava tube that runs under the landfill.
- The landfill was closed around 1993 with an engineered PVC cap and gas extraction system.


Site Location
Honokaa
Kawaihae
Waimea
Laupahoehoe
Waikoloa Village
Honomu
Mauna Kea
Hilo Forest Reserve
Hilo
Kalaoa
Kailua-Kona
Island of Hawai'i
Mountain View
Hawaiian Beaches
Captain Cook
Pāhoa
Mauna Loa
Honaunau-Napoopoo
Volcano
Pahala
Milolii
Kau Forest Reserve
Ocean View
Naalehu

Underlying Geology:
A'a Lava Rock and Lava Tubes

- The A'a lava underlying the landfill is highly porous. A'a is formed when the lava runs fast and cools quickly resulting in a clickery looking rock.
- Local residents attest to having observed lava tubes located under the landfill. Lava tubes are formed when an active low-viscosity lava thickens and forms a "roof" over a less-viscos lava stream.

A'A Lava

Lava Tube

Landfill Closure and Subsurface Landfill Fires

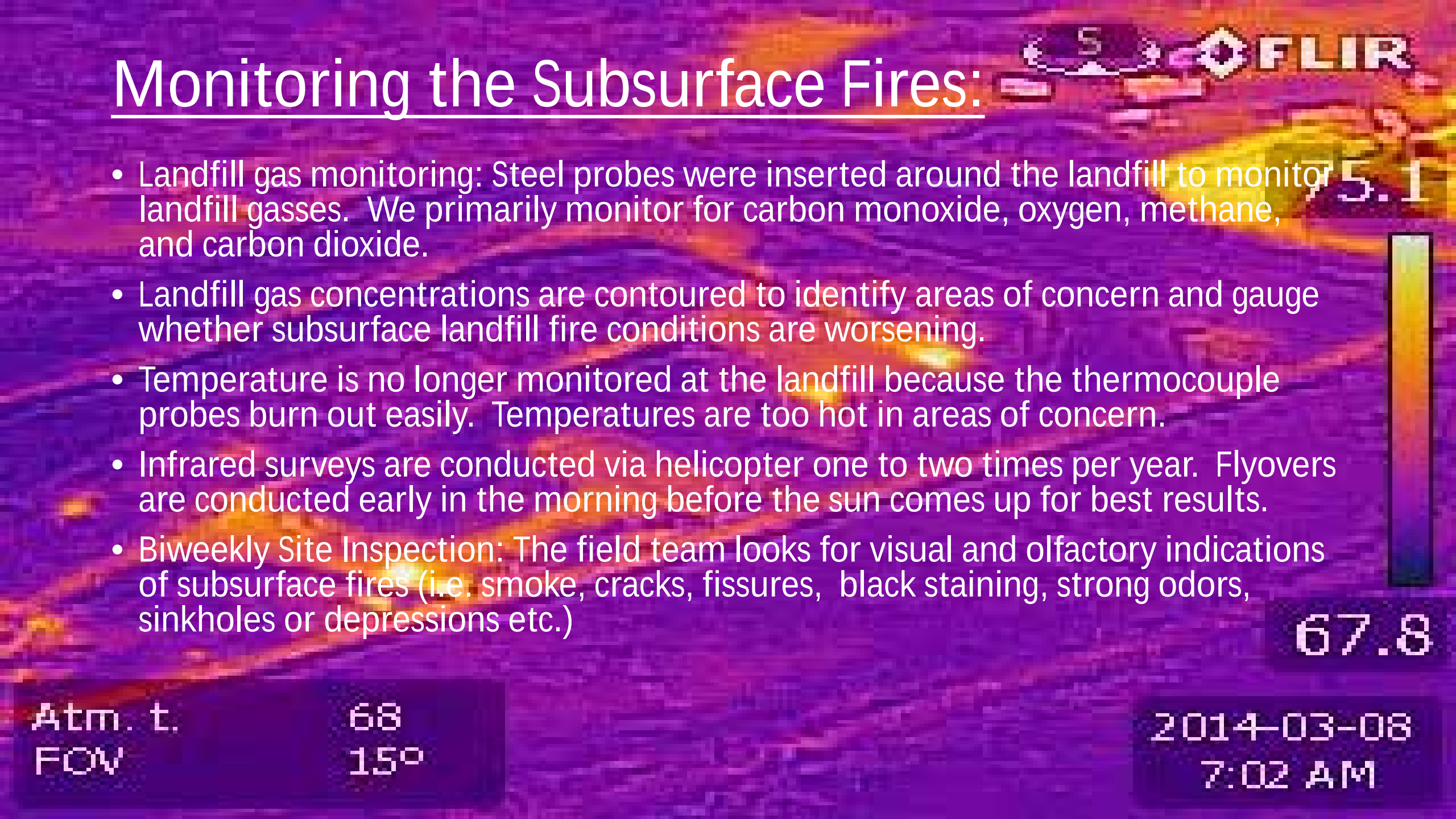
- Subsurface landfill fires were occurring at the time of closure in 1993 and 1994 and presented problems with the post-closure design.
- The final cap consisted, from the waste up, of 4-7 inches of ¾-inch base course, 40 mil PVC, 12-inches of ¾-inch base course, and 12-inches of soil. During closure and presently, the PVC is easily melted which creates areas where oxygen can infiltrate.
- The landfill gas management system was installed and was immediately damaged due to high temperatures. The horizontal trench system was constructed of PVC pipe which melted easily. The gas system and flare was never used and instead became a pathway for oxygen infiltration.

Ongoing Issues with Controlling the Subsurface Oxidation/Combustion issue at the Landfill:

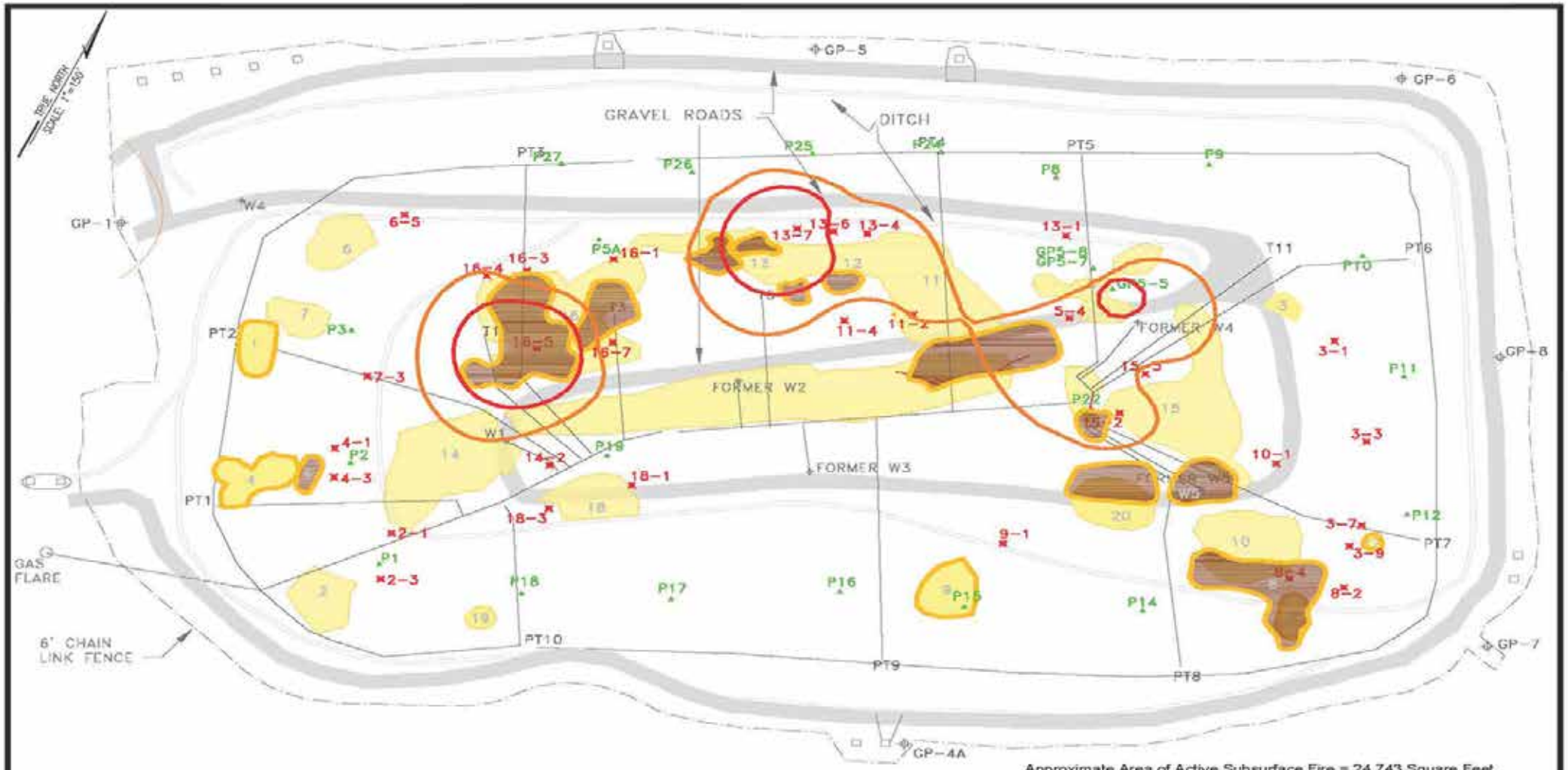
- The underlying geology is very porous and provides unlimited oxygen to the fires if the cap is not maintained.
- Low permeability cover material is difficult to find in large quantities.
- The PVC cap melts easily.
- The landfill gas extraction system may still be allowing preferential flow of oxygen through the landfill.
- There is still plenty of combustible material in the landfill.
- The climate is arid on the Kona (leeward) side of the island and trade winds are constantly blowing.

Monitoring the Subsurface Fires:

- Landfill gas monitoring: Steel probes were inserted around the landfill to monitor landfill gasses. We primarily monitor for carbon monoxide, oxygen, methane, and carbon dioxide.
- Landfill gas concentrations are contoured to identify areas of concern and gauge whether subsurface landfill fire conditions are worsening.
- Temperature is no longer monitored at the landfill because the thermocouple probes burn out easily. Temperatures are too hot in areas of concern.
- Infrared surveys are conducted via helicopter one to two times per year. Flyovers are conducted early in the morning before the sun comes up for best results.
- Biweekly Site Inspection: The field team looks for visual and olfactory indications of subsurface fires (i.e. smoke, cracks, fissures, black staining, strong odors, sinkholes or depressions etc.)



Example of IR Photo:



Legend

- Perimeter Gas Monitoring Probe
- Gas Extraction Well
- Gas Injection Probe
- Monitoring Probe
- Ditch
- Perimeter Fence
- Gas Extraction System
- Road
- Fissure
- Sinkhole
- Recently Filled Sinkholes (Fill Boundaries Surveyed)
- Approximate Area of Potential Subsurface Fire (300 ppm CO contour)
- Approximate Area of Active Subsurface Fire (500 ppm CO contour)
- Extrapolated Limits of Areas

Probe and sinkhole locations are approximate.

0 150 300

Scale In Feet

Base Map: March, 2004, Walker Consultants, Ltd., Site Map for Kailua Landfill, Figure 2A

Project:	140036
Approved by:	LBM
Drawn by:	AKP
Date:	OCT 2015
Scale:	1"=150'

Figure 9
Approximate Fire Boundary as of June 2015
County of Hawaii
Kailua-Kona Landfill
2nd Quarter 2015 Fire Monitoring Report
Kona, Hawaii, Hawaii

element environmental, llc
environmental engineering water resources

Mitigation of Subsurface Landfill Fires:

- **Application of Cover Material:** Cover material is applied and compacted where erosion has occurred, large sinkholes are forming, and/or cracks or fissures are observed. This has been the most effective way to mitigate the subsurface fires at the landfill. Conditions have improved since implemented.
- **Closure of Vertical Landfill Gas Extraction Well:** The gas wells were always hot and burning. The wells were grouted and covered with fill material.
- **Vegetation Control:** Cattle graze on the site to keep the vegetation under control. Thick vegetation can become a surface fire hazard and make it difficult to conduct site inspections.
- **Carbon Dioxide Injection:** Carbon dioxide was regularly injected in the areas where active combustion was occurring, but is no longer conducted because application of cover is a better use of limited funds.

Future Plans for the Landfill:

As one could guess, property values are on the rise in Hawaii. The once rural setting surrounding the closed landfill is being developed. Currently, the police station, animal shelter, transfer station and high school are located near the landfill. There is also a preliminary plan for an affordable housing neighborhood located adjacent to the landfill. As the area is built up, concerns about air quality will be at the forefront.

On a positive note, there have been no complaints from neighbors since we began managing the site. This is due to the diligent cover maintenance program that we have implemented.


Closed Kailua-Kona Landfill
Kealakehe Pkwy
Kealakehe Pkwy
Queen Kaʻahumanu Hwy
Aupaka Pl
Paia Pl
Kanohale Loop
Na Wai Iwi Ola
Haleolono Pl
Puohulihuli St
Drive E
Drive D
Drive C
Kealakehe High School
Keanalehu Dr
Keanalehu Dr
Aneʻkeohokaloleʻi Hwy
Aneʻkeohokaloleʻi Hwy
Kealakehe Transfer Station and Recycling
Hale Makai Pl
Hawaii Island Humane Society
West Coast Towing
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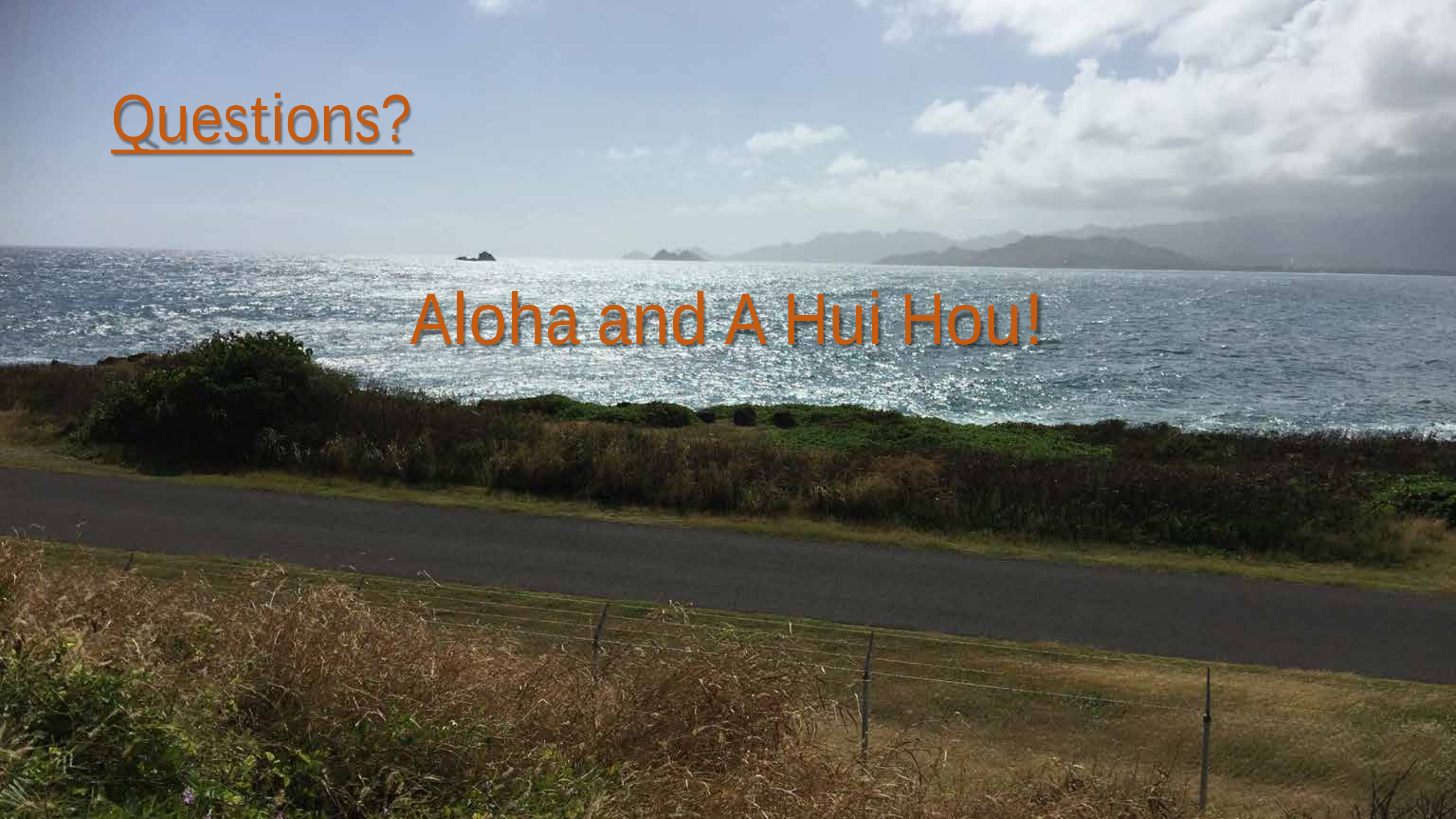
Future Plans Continued:

- **Relocation of the waste:** The waste could be relocated to another landfill on island but there are major health and safety concerns with digging into the landfill and moving the waste. This option is extremely expensive, dangerous and could pose subsurface landfill fire issues in the receiving landfill.
- **Construction of a New Engineered Cap:** Construction of an engineered cap could be used to limit oxygen infiltration into the waste mass and limit the current “chimney effect” that is occurring at the landfill now. This option would be very costly and would require continued maintenance and monitoring.
- **Implementation of a New Technology:** We are currently looking into a technology used to extinguish subsurface coal fires. The technology works by injecting a foam mixture into the waste mass. The foam is comprised of a biodegradable fire retardant and is injected using nitrogen gas. The foam wets and cools the area of combustion.


Questions?
Aloha and A Hui Hou!