POHAKEA WATERSHED / MA‘ALAEA BAY
MAUI COUNTY, HAWAII
STORMWATER MANAGEMENT PLAN

Prepared for:
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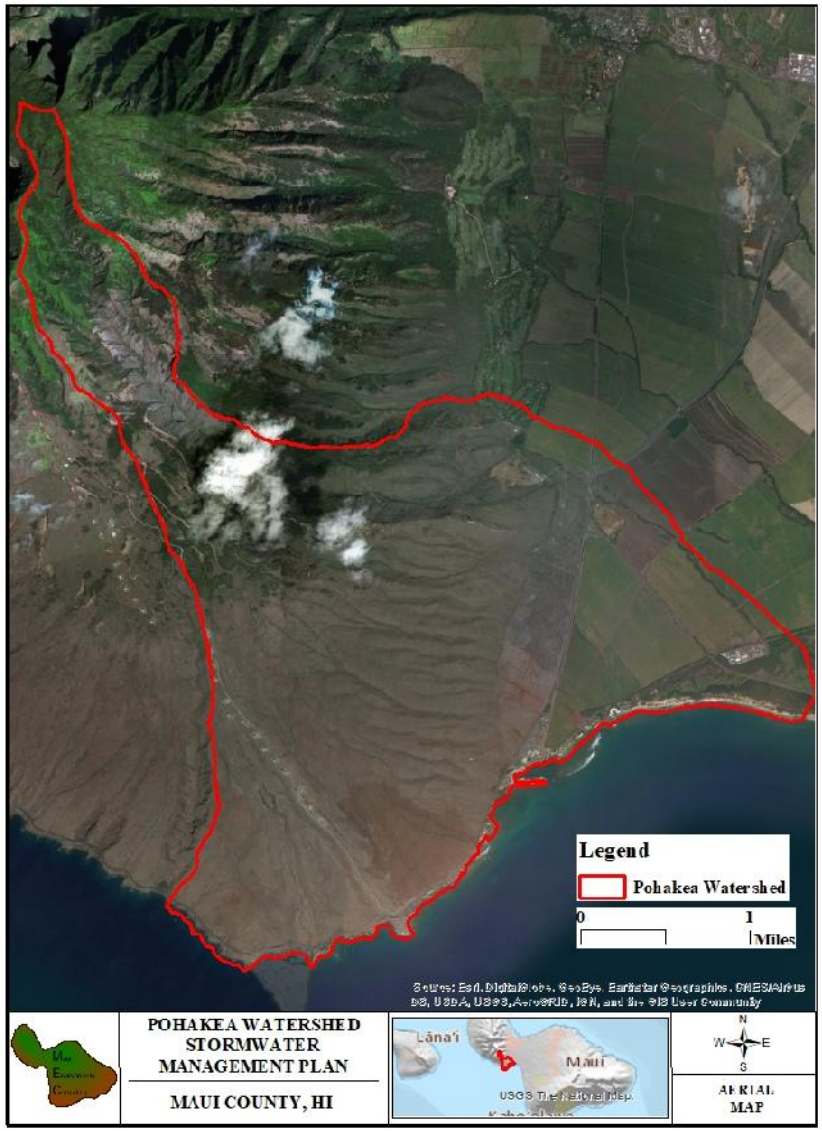
Purpose of the Stormwater Management Plan

- Maui Nui Marine Resource Council wanted a study conducted of the Pohakea Watershed without the expense and timeline associated with a full watershed plan.
- At the request of MNMRC, Maui Environmental Consulting, LLC (MEC) reviewed the Pohakea Watershed for current landscape conditions affecting water quality within Ma‘alaea Bay.
- This study focused on erosion and sediment transport caused by surface water flow during stormwater events.
- Any on-site observations of nutrient, pathogen, or other pollutant sources, as well as any other land management practices that may be contributing to water quality degradation in Ma‘alaea Bay or Ma‘alaea Harbor were recorded.

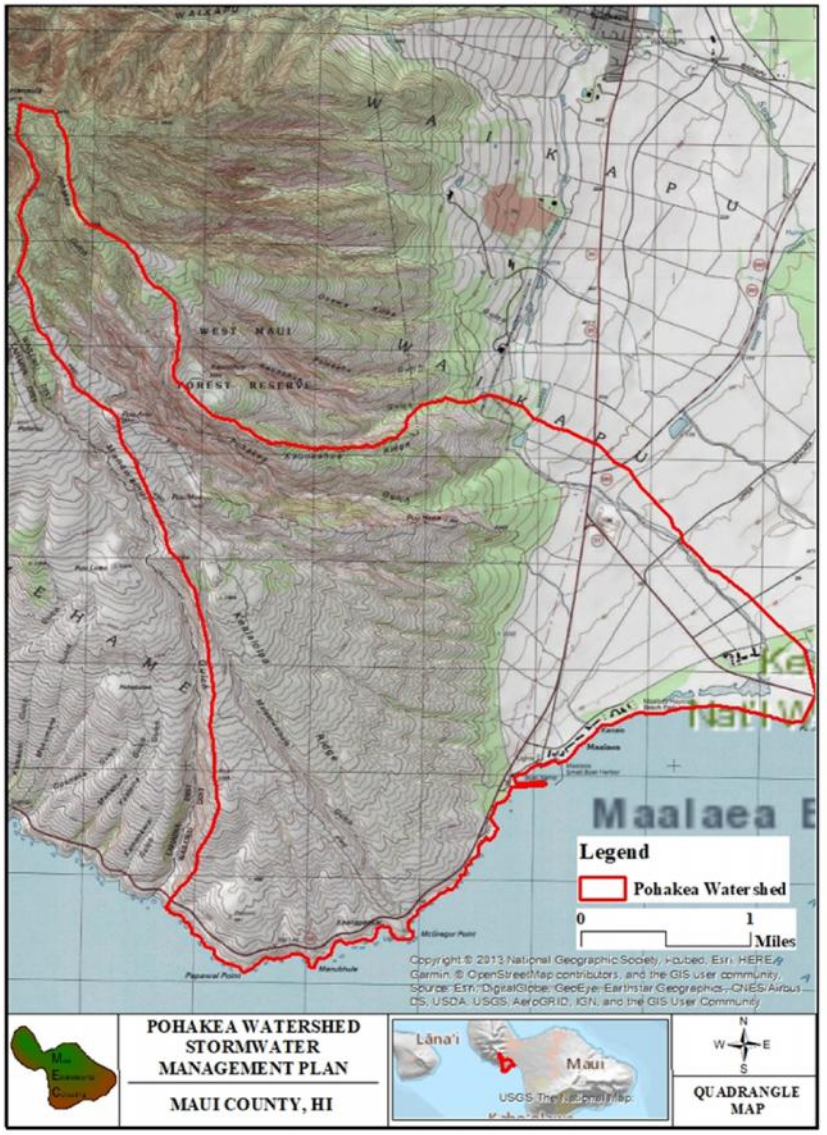
Pohakea Watershed Characterization:

- The Pohakea Watershed begins at approximately 4,600 feet at the summit of Hanaula within the West Maui Mountains.

- Along the coast, this watershed stretches from Kealia Pond and continues west past McGregor's Point to the eastern ridge of Manawainui Gulch



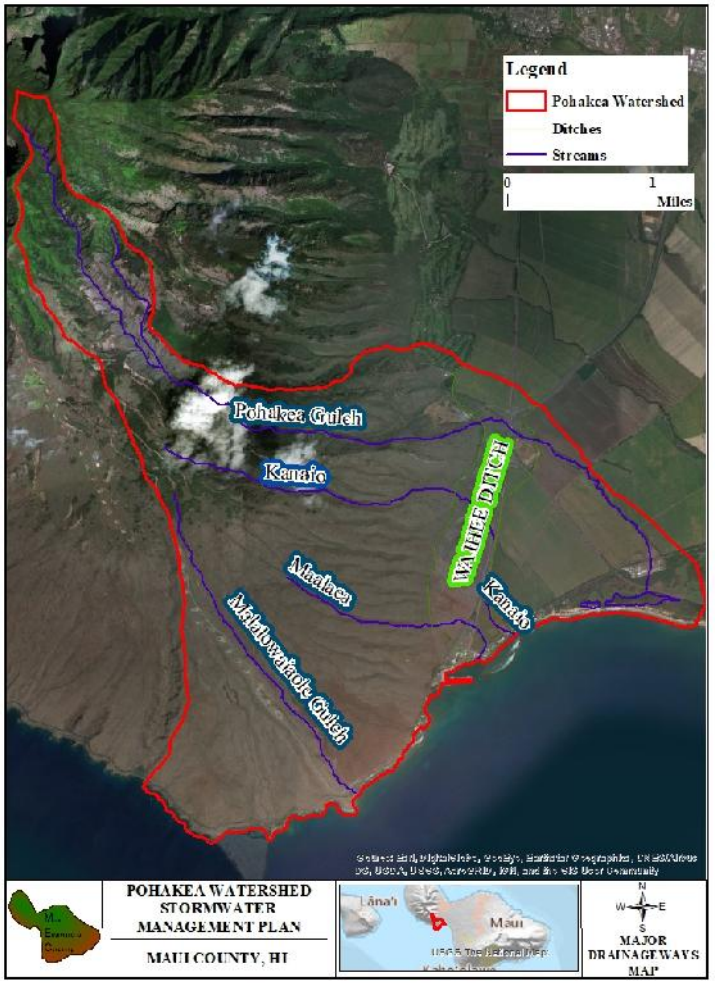
- The approximately 5,268-acre watershed is composed of several different land formations.
- The watershed flows south and east through several gulches that all discharge into Ma‘alaea Bay or Ma‘alaea Harbor.
- Hillslope is relatively steep at the upper portions of the West Maui Mountains, with grade leveling off considerably at approximately 400 feet and continuing to gradually drop along the coastal areas to the ocean



Pohakea Watershed Landscape and Major Drainageways

Pohakea Gulch

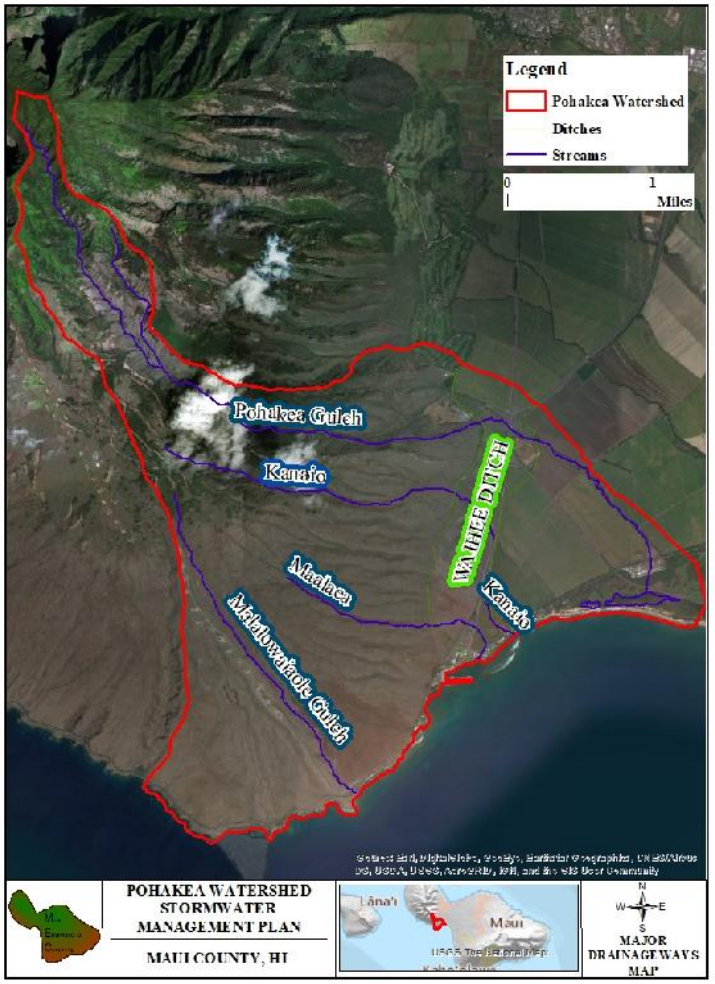
- As its name implies, the major landscape feature within the watershed is Pohakea Gulch.
- This deeply incised gulch flows almost due east, passing just south of the Hawaiian Cement Quarry located at the end of Kuihelani Road and continuing across Honoapi‘ilani Highway via a culvert system, north of the privately owned and now permanently closed Maui Construction and Demolition Landfill.
- Pohakea continues to flow through agricultural fields, paralleled by Maui Electric (MECO) powerlines before wrapping around the northern boundary of the oil powered 212.1 megawatt MECO Ma‘alaea Powerplant.
- From here, Pohakea discharges into Kealia Pond National Wildlife Refuge and ultimately into Ma‘alaea Bay.



Pohakea Watershed Landscape and Major Drainageways

Kanaio Gulch

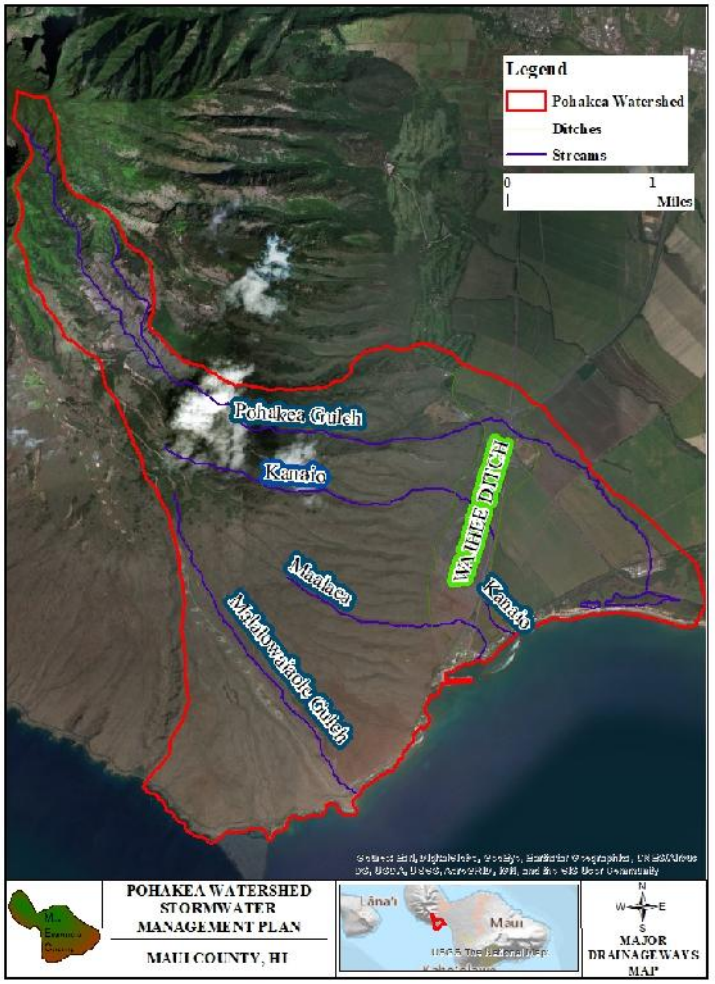
- Kanaio Gulch begins south of Pohakea Gulch at the base of Pu‘u Moe at approximately 2,400 feet.
- The gulch flows east toward Honoapi‘ilani Highway. Historically, this stream continued across the highway and through what is now fallow agricultural land before terminating at what is today Haycraft Beach Park.
- Currently, the stream passes under the highway via culvert, and is then diverted into a box-cut concrete lined ditch (Waihe‘e Makai Ditch) on the makai side of Honoapi‘ilani Highway.
- This ditch then disches into a detention basin mauka of Hau‘oli Street and the Maui Island Sands Resort. This detention basin has recently failed and is currently under repair.
- Water from both Kanaio and the unnamed gulches then passes under Hau‘oli Street via culvert, passing through a concrete lined drainageway in between Maui Island Sands Resort and the Ma‘alaea Banyans before discharging into Ma‘alaea Bay



Pohakea Watershed Landscape and Major Drainageways

Ma‘alaea Gulch

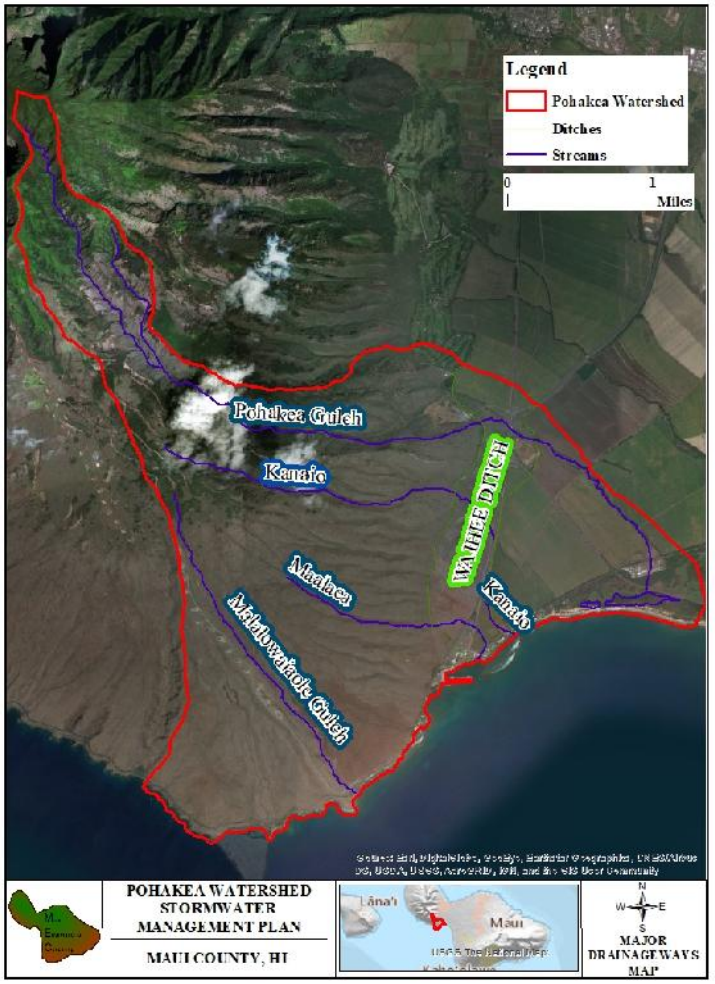
- Ma‘alaea Gulch is located south of the unnamed gulch associated with Kanaio Gulch mentioned above.
- Ma‘alaea gulch begins at approximately 1,800 feet, flowing east towards Honoapi‘ilani Highway.
- From here, the gulch enters a culvert and remains underground until it discharges into Ma‘alaea Harbor.
- In addition to Ma‘alaea gulch, at least three other small unnamed gulches flow east to the highway before entering culvert systems that discharge into Ma‘alaea Harbor makai of the intersection of Honoapi‘ilani Highway and Ma‘alaea Road.



Pohakea Watershed Landscape and Major Drainageways

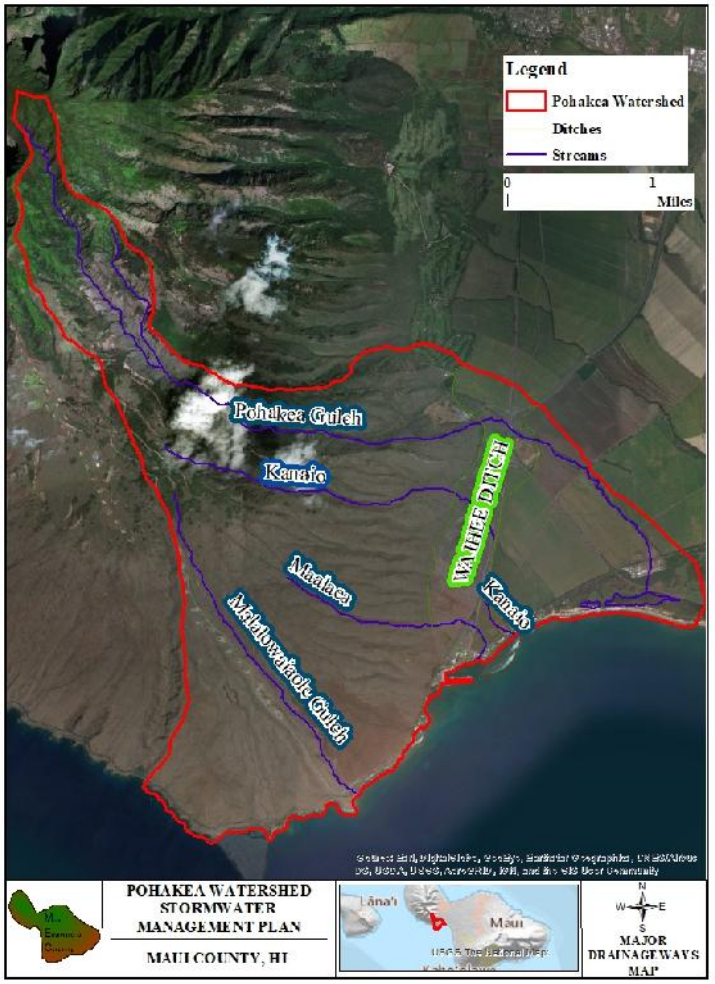
Malalowaiaole Gulch

- Malalowaiaole Gulch originates at approximately 2,000 feet.
- This gulch is at the eastern flank of Kealaloloa Ridge. This ridge is home to the Kaheawa Wind Power wind farm and its associated access road. Malalowaiaole Gulch flows southeast towards the base of the dirt access road.
- From here, the system enters large culverts as it passes under the dirt road before continuing along the Honoapi‘ilani Highway where it again enters a culvert system before finally discharging into coastal waters east of McGregor Point.



Pohakea Watershed Landscape and Major Drainageways

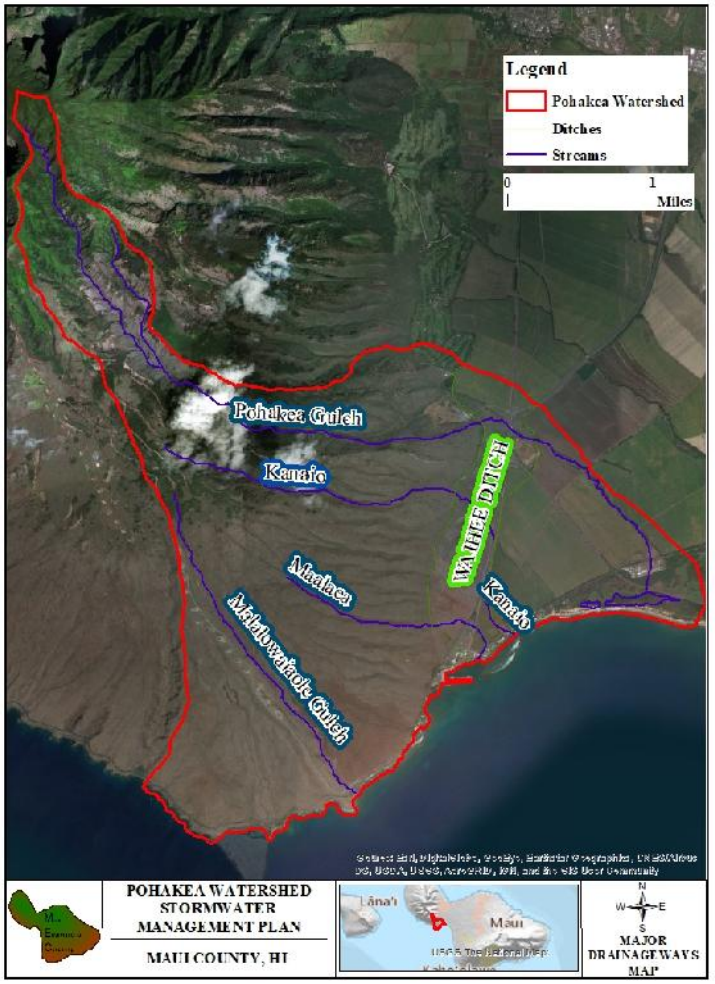
- Beyond Malalowaiaole Gulch, three unnamed gulches discharge into coastal waters through culvert systems under Honoapi‘ilani Highway.
- One discharges east of Manuohule Point and the other two flank the Papawai land formation, located at approximately 381 feet, discharging into coastal waters on either side of Papawai Point.
- Additional culverts exist west of Malalowaiaole Gulch where gullies and gulches run under the highway. Due to the unsafe conditions caused by heavy traffic and narrow road shoulders associated with the Pali, MEC staff did not record GPS positions of these culverts.



Pohakea Watershed Landscape and Major Drainageways

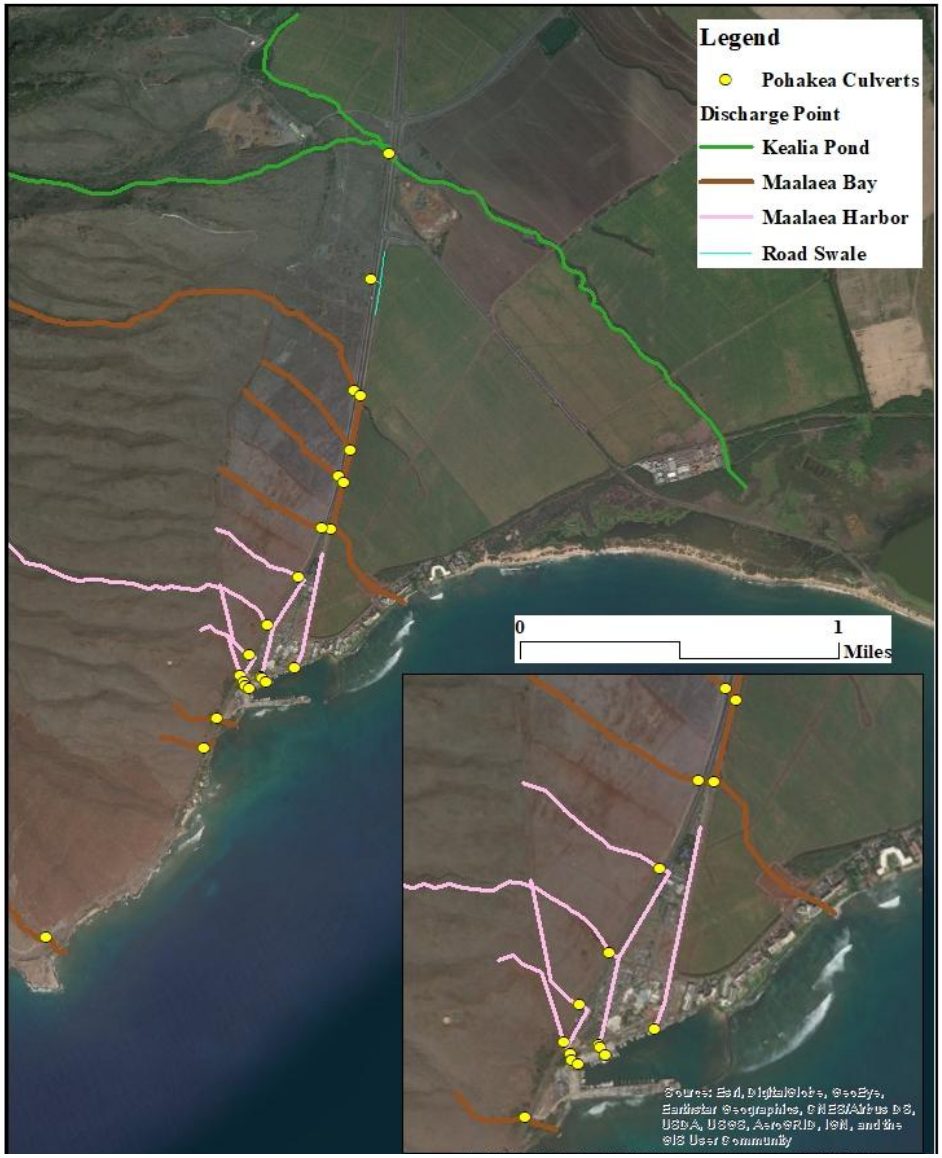
Waiheʻe Ditches

- In addition, Waiheʻe Mauka Ditch runs north to south along the base of the West Maui Mountains, where steep hills transition to relatively flat coastal lands. This ditch discharges into Pohakea Gulch before ultimately flowing into Kealia Pond.
- A second ditch, also named Waiheʻe Ditch, is referred to as Waiheʻe Makai Ditch in this report for clarity. Waiheʻe Makai Ditch historically flowed along the makai side of Kuihelani Highway, wrapping around the landfill before crossing under North Kihei Road and continuing on the makai side of Honoapiʻilani Highway.
- The ditch now appears to begin along the highway and continue south, connecting with Kanaio Gulch and three unnamed ditches before continuing on through the failed detention basin and ultimately discharging into Maʻalaea Bay.



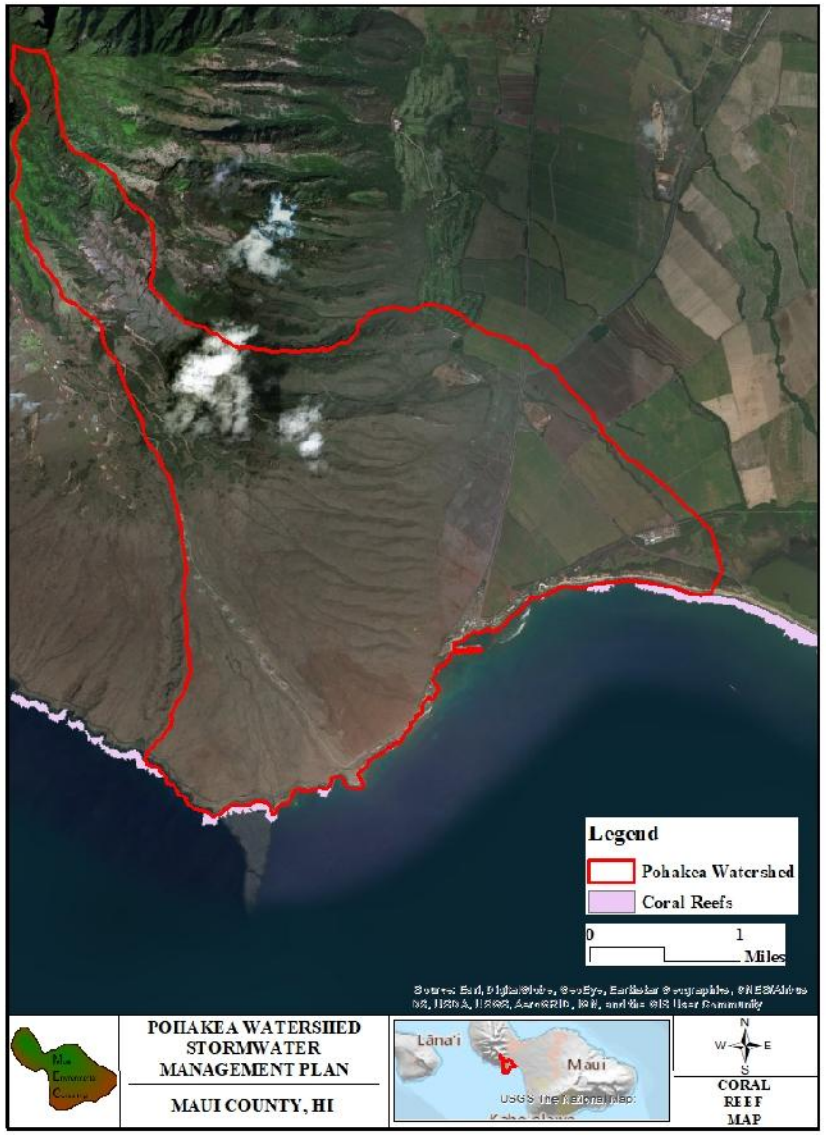
Discharge Pathways:

- As shown in the map to the right, Pohakea Gulch and Waiheʻe Ditch Mauka discharge into Kealia Pond.
- Kanaio Gulch and several unnamed gullies discharge into Maʻalaea Bay
- Maʻalaea Gulch and several unnamed gullies discharge into Maʻalaea Harbor.
- Malalowaiaole Gulch flows into Maʻalaea Bay near McGregor's Point.



Pohakea Marine Environments

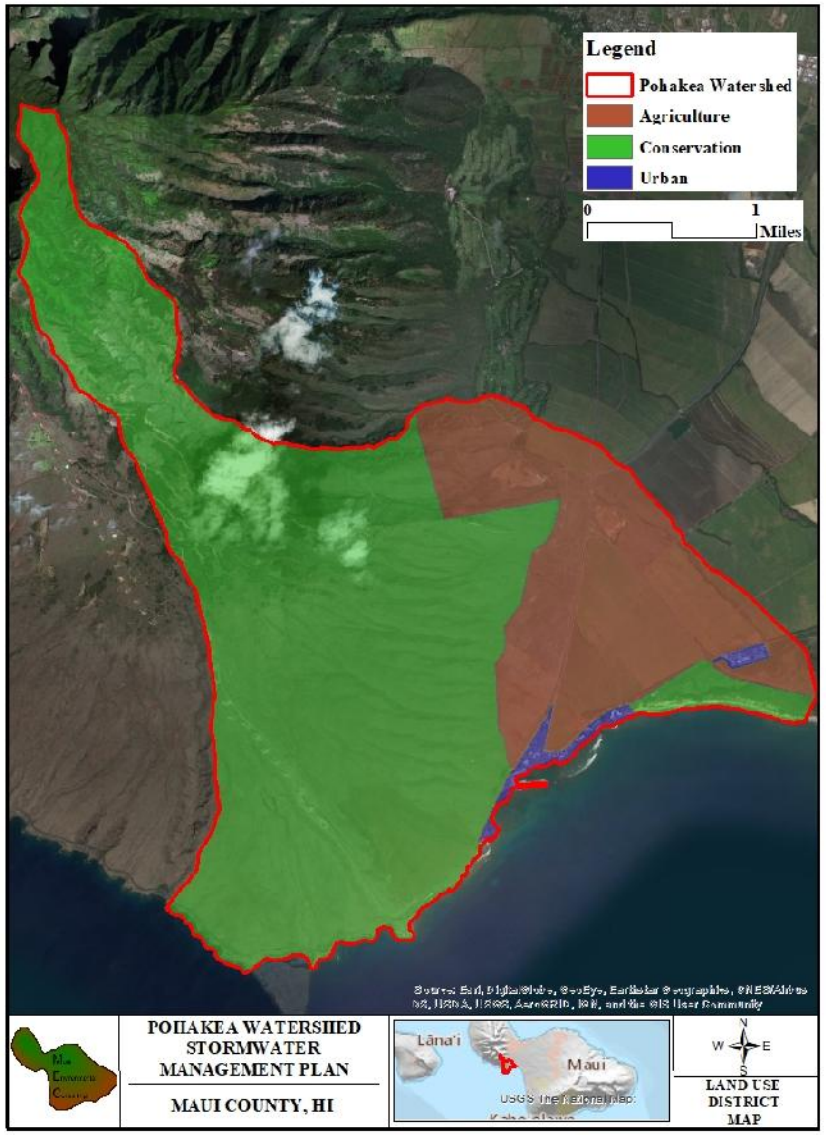
- Coral reef exists directly offshore extending west from McGregor Point beyond the coastal boundary of the watershed.
- Coral reef begins east of Haycraft Park and extends to Kealia Pond and beyond.
- Benthic habitat is comprised of “pavement” or exposed rock horizontal with the sea floor with many crevices or joints, aggregate reef, aggregate patch reef, rock, rubble, sand, and scattered coral and rock composites.



Pohakea Land Use Districts

- Three land use districts exist within the boundary of the Pohakea Watershed.
- The largest district being conservation lands at approximately 3,873 acres.
- Agricultural lands make up 25 percent of the watershed.
- Urban land represents a relatively small portion within the watershed and is comprised of the business district associated with Ma‘alaea Harbor.
- State land use boundaries were compiled by the State Land Use Commission and were most recently updated in 2014.

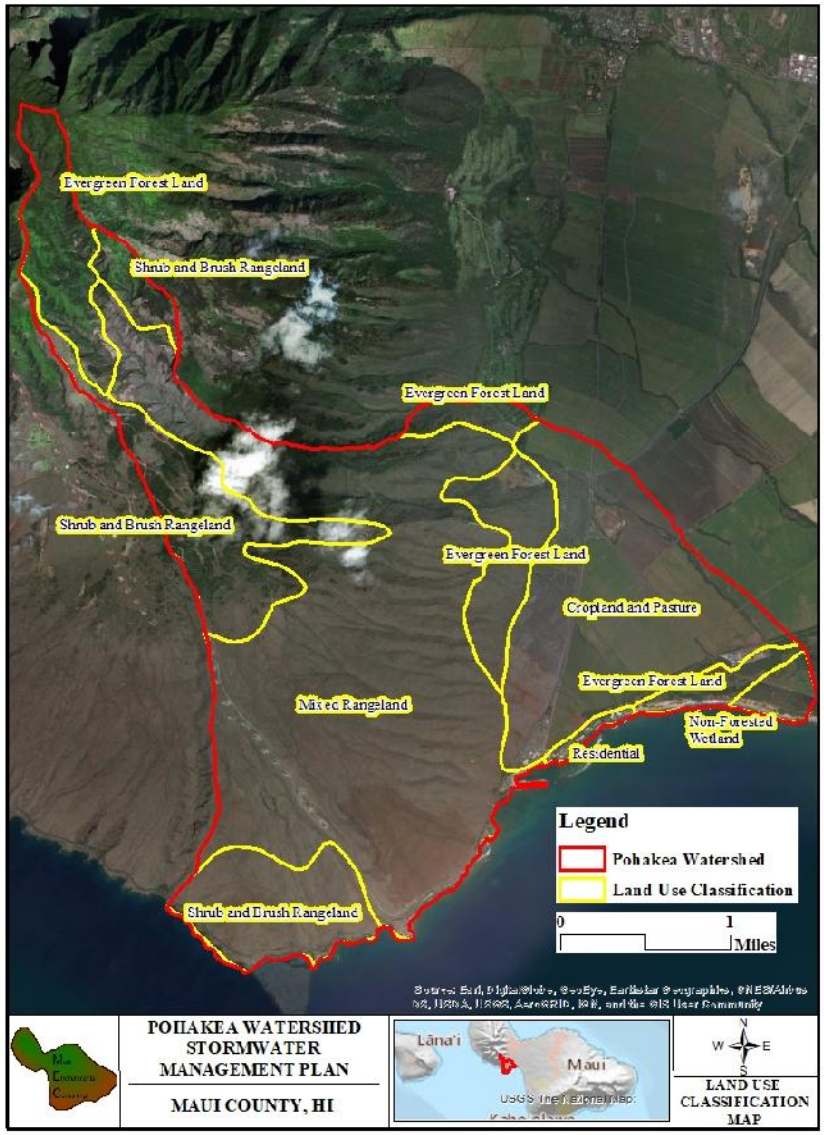
Land Use District	Acres	Percent
Conservation	3873.36	73.53
Agriculture	1317.23	25.00
Urban	77.44	1.47



Pohakea Land Use Classifications

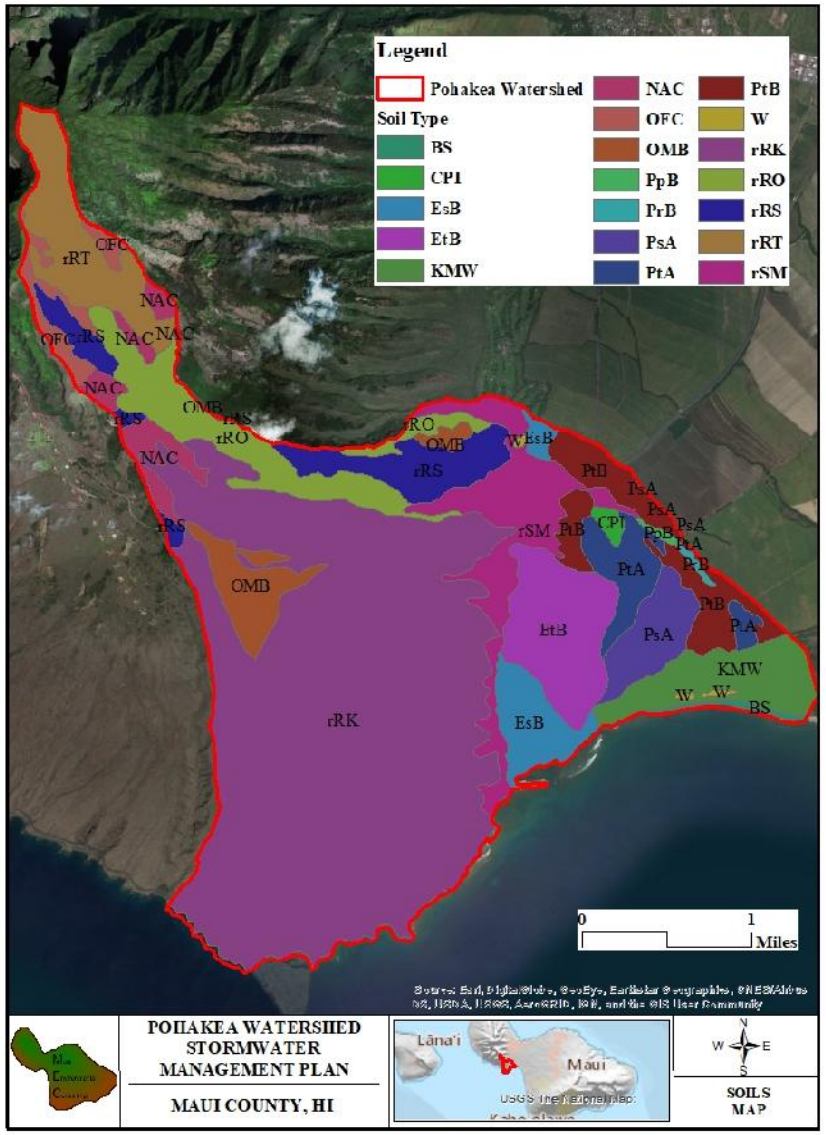
- Within the Pohakea Watershed boundary, six land cover types exist.
- These include Mixed Rangeland, Cropland and Pasture, Shrub and Brush Rangeland, Evergreen Forest Land, Non-forested Wetland, and Residential.
- Mixed Rangeland is the largest land cover type, making up nearly half of the watershed
- State land use and land cover data consists of historical land use and land cover classifications that were based on the manual interpretation of 1970's and 1980's aerial photography. There are 21 possible categories of cover type.

Land Cover	Description	Acres	Percent
33	Mixed Rangeland	2480.80	47.09
21	Cropland and Pasture	1044.25	19.82
32	Shrub and Brush Rangeland	932.69	17.70
42	Evergreen Forest Land	707.72	13.43
62	Non-Forested Wetland	72.72	1.38
11	Residential	29.85	0.57



Pohakea Soils

- Based on the USDA/NRCS Soil Survey for Maui County (Version 15, October 3rd, 2017), 19 soil types are mapped within the Pohakea Watershed
- As seen in the Soils Map, rRK – Rock Land is the dominant soil type within the Pohakea Watershed. This soil type is considered well drained with very high runoff potential.
- Similar soil types with high runoff potential include rRO – Rock Outcrop, rRS – Rough Broken and Stony Land, rRT – Rough Mountainous Land, and rSM – Stony Alluvial Land and are found throughout the upper and middle ranges of the watershed where slopes are steepest. NAC – Naiwa Silty Clay Loam and OFC – Olelo Silty Clay are also found in the upper reaches of the Pohakea Watershed and have high runoff potential.



POTENTIAL SOURCES OF POLLUTION

- Sediment, nutrient, and other pollutant sources associated with the Pohakea Watershed were assessed using field observations made during three field events occurring on July 26th, July 27th, and August 29th, 2018.
- MEC staff canvassed the watershed to identify and photo-document sources of sediment and areas with high erosion potential due to both natural and anthropogenic circumstances.
- Specifically, when looking for evidence of erosion, MEC recorded observations of head cuts, bare ground, rills and channels on the soil surface.
- In addition, failed Best Management Practices, failed or non-functioning infrastructure, and improper or outdated land management strategies were also documented.

POTENTIAL SOURCES OF POLLUTION

Conservation Lands

1. Unimproved Roads

- Historic land uses in this area (primarily cattle ranching) have left behind an extensive network of unimproved and unmaintained agricultural roadways.
- Some roadways are deeply incised into the landscape, an indication of long-term sediment loss and erosion.
- Disused and unmaintained roadways are acting as stormwater conveyance mechanisms during rain events, and are channeling stormwater and sediment into adjacent gulches.

POTENTIAL SOURCES OF POLLUTION

Conservation Lands

2. Powerline Corridors

- There are a number of powerline corridors associated with transmission and distribution power lines.
- The status of these lines is unknown, but downed lines, and aging poles were observed at several locations.
- In addition, recently burned areas were observed directly below transmission corridor power lines.
- The powerline access roads for these corridors were observed to be in various states of disrepair, and the clearing of vegetation from under and around the power lines has created bare areas which, like agricultural roads act as stormwater and sediment conveyances

POTENTIAL SOURCES OF POLLUTION

Conservation Lands

3. Land Slides

- It was observed that native scrub habitat was being lost as topsoil sloughed off and ‘mini’ landslides were occurring.
- Steep slopes combined with a groundcover predominance of non-native/invasive plant species have caused structural failures of topsoil layers when the soil becomes over saturated with water and sloughs off of the rocky underlying bedrock.
- A gradual loss of native habitat as non-native species encroach seems to increase this sloughing process leaving behind a series of ‘badlands’ - areas of exposed bedrock that can support little to no vegetation.

POTENTIAL SOURCES OF POLLUTION

Mid-Level Agricultural Lands

1. Head Cuts

- Substantial loss of sediment was observed along the upstream side of the highway where stream flow was directed underneath the highway through box drains and culverts.
- The constriction point created by these culverts, possibly due to their being undersized, has led to extensive head cutting within the stream channel and loss of many tons of sediment material during times when the streams flow.

POTENTIAL SOURCES OF POLLUTION

Mid-Level Agricultural Lands

1. Head Cuts Continued

- Head cuts occur when stream force is directed downward due to a constriction of flow (in this case a road culvert), and creates a sheer bluff or cliff known as the knickpoint.
- The head cutting observed was 'active' in that more stream channel incision, loss of floodplain connectivity, and loss of sediment at an exponential rate will continue and worsen as the knickpoint migrates further upstream each time the stream flows.

POTENTIAL SOURCES OF POLLUTION

Mid-Level Agricultural Lands

2. Waihe'e Ditches

- The Waihe'e Mauka ditch is evident in the northern portion of the watershed until it converges with Pohakea Gulch.
- The remaining portion of the original Waihe'e Mauka Ditch runs essentially north/south at the inflection point between the mountains and the relatively flat plain.
- A reservoir located at the southern end of the Kahili Golf Course appears to be the terminus of the actively used portion of the Waihe'e Mauka Ditch.
- While the ditch was observed to be dry within the project area, during high rain events, it could discharge additional sediment laden stormwater into Pohakea Stream.

POTENTIAL SOURCES OF POLLUTION

Mid-Level Agricultural Lands

2. Waihe'e Ditches

- The Waihe'e Makai Ditch has also been altered from its original extent.
- The ditch is an armored, box-cut channel beginning along Honoapi'ilani Highway flowing south, severing Kanaio Gulch from its original course, becoming a more natural, unarmored system after receiving water from three additional unnamed gulches that are routed via culvert under the highway.
- At the confluence of this ditch with the third unnamed gulch on the makai side of the highway, the system turns southeast, losing its concrete lining and continuing through the failed detention basin associated with Hauoli Street before ultimately discharging into Ma'alaea Bay.

POTENTIAL SOURCES OF POLLUTION

Mid-Level Agricultural Lands

3. Fire Breaks and Powerlines

- Extremely windy conditions and aging infrastructure make powerline corridors vulnerable ignition sources for wildfires.
- The loss of vegetation and subsequent erosion resulting from wildfires is well documented in this area, and every effort should be made to prevent their occurrence

POTENTIAL SOURCES OF POLLUTION

Commercial and Urban Land

1. Stream Diversions

- The cut off reach of Kanaio Stream that was diverted into the armored channel (Waiheʻe Makai Ditch) running parallel to the Highway, still exists as a dry gulch that continues through fallow sugar cane fields from the highway until it terminates in the field mauka of Haycraft Beach.
- It is likely that this stream once flowed into wetlands in the vicinity of Haycraft. Further investigation of the historic hydrologic conditions in this area are recommended to inform potential restoration activities.

POTENTIAL SOURCES OF POLLUTION

Commercial and Urban Land

2. Dirt Lots and Parking Lots

- Vacant lots and dirt parking lots are found in the areas adjacent to the harbor.
- While some of these areas have been improved with a gravel overlay, many are simply bare compacted earth which can easily be transported to the nearby ocean by wind and rain.
- In particular, the paid parking located near the Pacific Whale Foundation embarkation area and the parking areas at the west (towards Lahaina) end of the harbor are bare dirt right next to the ocean.

POTENTIAL SOURCES OF POLLUTION

Commercial and Urban Land

3. Ma'alaea Triangle Parking Lot

- The parking lots that service the Ma'alaea Triangle represent approximately 350,000 square feet of impervious surface.
- This area is a potential source of considerable urban stormwater runoff and its associated pollutants during rain events.
- While the drains are stenciled to indicate that they lead to the ocean, the stormwater entering them receives no treatment before being discharged directly into the harbor.
- Runoff from parking lots contains sediment as well as petrochemicals, heavy metals, trash, and other pollutants associated with urban runoff.

POTENTIAL SOURCES OF POLLUTION

Commercial and Urban Land

4. Car Washes and Condo Impervious Surfaces

- The roads, parking lots and buildings associated with the oceanfront resorts and condominiums along Hauʻoli Street represent a significant area of impervious surface.
- Runoff from these areas increases the volume of stormwater runoff flowing into the ocean, and, is potentially a significant contributor of sediment as well as petrochemicals, heavy metals, trash, and other pollutants associated with urban runoff.
- Swimming pool backwash and car washing areas were also observed discharging directly into the channelized stream which flows into the ocean.
- There are likely additional sources of nutrient pollution within the landscaped areas of these condominiums.

MANAGEMENT PROJECTS AND STRATEGIES

The Pohakea watershed is characterized by long periods of up to several years with little to no rainfall.

Discharge from gulches and gullies into Ma‘alaea Harbor and Ma‘alaea Bay rarely occur.

Unfortunately, when stormwater events do occur, the potential for flash floods, and very large stormwater volumes is possible within this watershed.

The occurrence of these extreme flooding events is only likely to increase as weather patterns change due to climate change.

Any stormwater mitigation measures and restoration activities must be engineered to handle the high flow events that will eventually occur.

MANAGEMENT PROJECTS AND STRATEGIES

Conservation Lands

1. Unimproved Roads

- In coordination with landowners and potential road users, disused, and unnecessary or redundant roadways should be identified for decommissioning.
- Roads likely to stay in use should be improved using water bars, sediment traps and other BMPs to minimize downslope transport of eroded sediments
- Roads for stabilization and closure should be prioritized based on 1) public use needs, 2) slope, 3) percentage of sand, silt, clay, and stone, 4) erosion and infiltration rates, and 5) likelihood of transport to streams/gulches

MANAGEMENT PROJECTS AND STRATEGIES

Conservation Lands

2. Wildfires

- Existing firebreaks should be maintained and new firebreaks should be established throughout the watershed.
- Vegetation should be maintained to reduce fuel loads and fire resistant vegetation should be planted whenever possible.
- After fires are extinguished, restoration activities should be coordinated and targeted to quickly stabilize newly burned areas with appropriate planting.
- Further study of the overall ecological response of plant communities and vegetation regrowth following fires in this particular area are needed.

MANAGEMENT PROJECTS AND STRATEGIES

Conservation Lands

3. Fire and Powerline Corridors

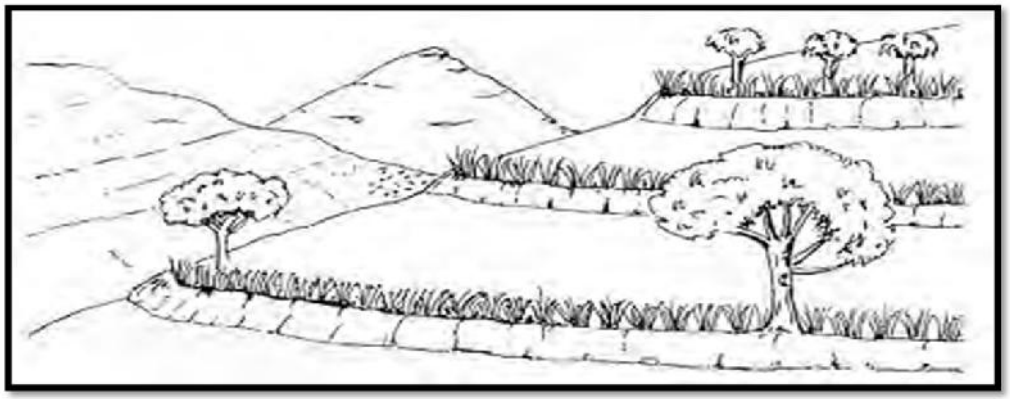
- Similar to the recommendations for unimproved roadways, the extent to which access is needed and vegetation must be controlled or removed from powerline corridors should be assessed.
- Disused or inactive corridors should be decommissioned, and active corridors managed to minimize disturbance of native vegetation while still maintaining corridor safety and access requirements.
- An assessment of where utilities can be place underground should also be conducted

MANAGEMENT PROJECTS AND STRATEGIES

Conservation Lands

4. Land Slides

- While the scale of this problem is extensive, attempts to mitigate the loss of topsoil and native vegetation caused by sloughing and mini landslides should be piloted in mauka areas adjacent to major gulches.
- Preserving high quality functional native habitat should be a priority.
- Drawing upon lessons learned from projects conducted in Hawai‘i and other high islands in the Pacific, a better understanding of the geologic processes causing this problem is needed.
- Hillslope stabilization methods could be employed at strategic locations in mauka lands that are vulnerable to landslides.
- Plant vetiver or other suitable vegetation on contour to stabilize actively eroding hillslopes, capture sediment, and to promote the infiltration of stormwater sheet flow into the ground so that it does not move laterally across the landscape.



MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

1. Head Cuts Immediately Mauka of Highway

- To better understand the amount of sediment lost during storm events, a head cut monitoring program should be implemented.
- Head cut stabilization is accomplished by either 1) excavating the actively eroding knickpoint (cliff) and incised stream banks to substantially reduce the slope, or 2) by filling in the incised channel below the knickpoint having the same result.
- Along the newly reshaped stream channel slope, boulders are used to create riffle pools which further reduce stream flow velocity and allow one pool to fill up before spilling into the next.
- Head cut stabilization and restoration is greatly enhanced by including native plants to further prevent erosion and maintain the new channel shape.

MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

2. Waiheʻe Makai Ditch System

- The hardened channel of the Waiheʻe Makai Ditch that runs adjacent to the highway collects substantial roadside rubbish and should be more effectively maintained as the bulk of this material is likely to end up in the ocean during a high flow event.
- It could be incorporated into ʻAdopt a Highway' programs, volunteer efforts from organizations like Malama Maui Nui, Maui County and/or Department of Transportation litter control efforts.
- Organizations that regularly do ʻBeach Cleanups' could be encouraged to clean up this channel as an alternative, and keeping this channel free of rubbish will likely have a far greater impact than waiting until this garbage makes its way downstream to the Ocean and onto beaches in Maʻalaea.

MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

3. Waiheʻe Mauka Ditch System

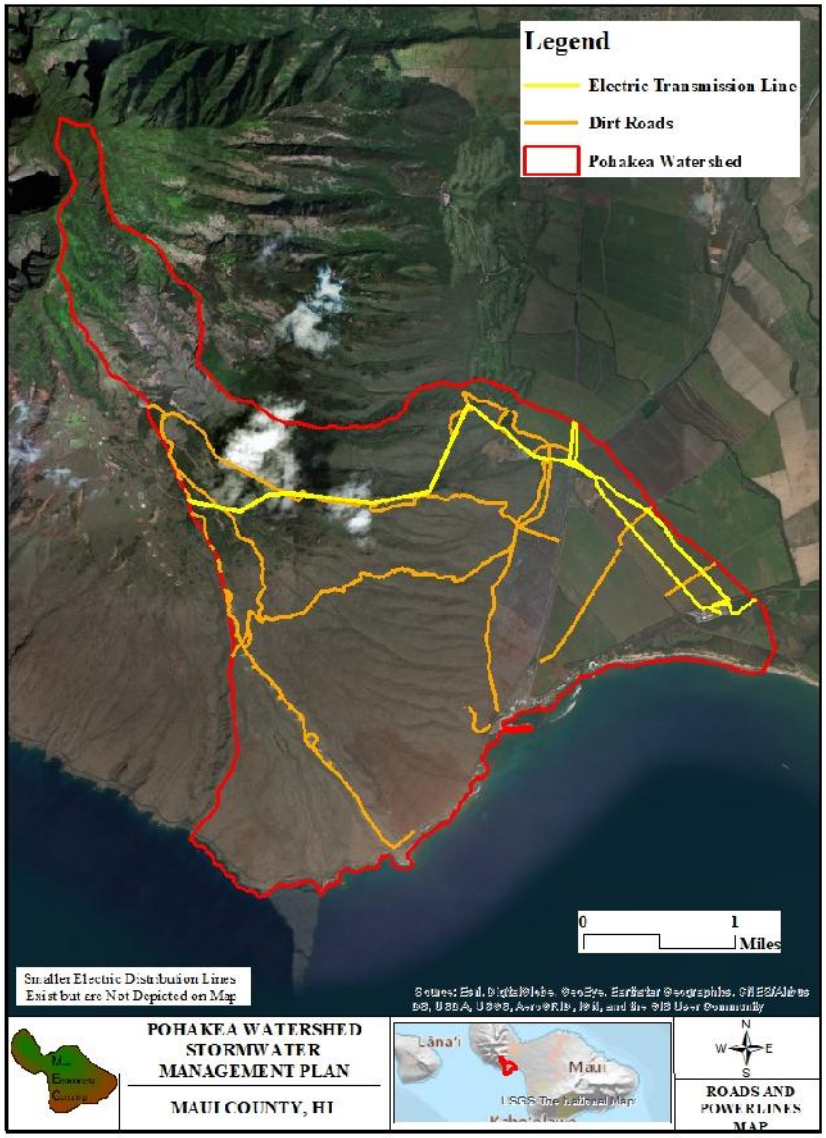
- The Waiheʻe Mauka Ditch pathway that is now being utilized as a powerline corridor is severely eroded and is an active sediment transport pathway during high flow events.
- This corridor was the source of mud flows running onto Honoapiʻilani Highway during recent storm events.
- This road represents a significant source delivering sediment into Maʻalaea Harbor and should be targeted for restoration activities.
- Restoration methods to capture and retain sediment suitable for this area are similar in nature to those found above and include decommissioning, water bars, swales, and detention basins.

MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

3. Powerline Corridors in Agricultural Lands

- While riparian corridors may provide linear pathways for utilities offering minimal impacts to available agricultural lands, these same areas are prone to flooding and can cause additional maintenance and safety issues in the long term for utility companies.
- Relocating this infrastructure away from stream corridors to follow agricultural roads instead will lower maintenance costs for utility companies while enabling farmers to partner with utility companies to share the cost of road maintenance.
- Wherever possible powerlines should be installed underground.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Pohakea Watershed
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Smaller Electric Distribution Lines Exist but are Not Depicted on Map
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ROADS AND POWERLINES MAP

MANAGEMENT PROJECTS AND STRATEGIES

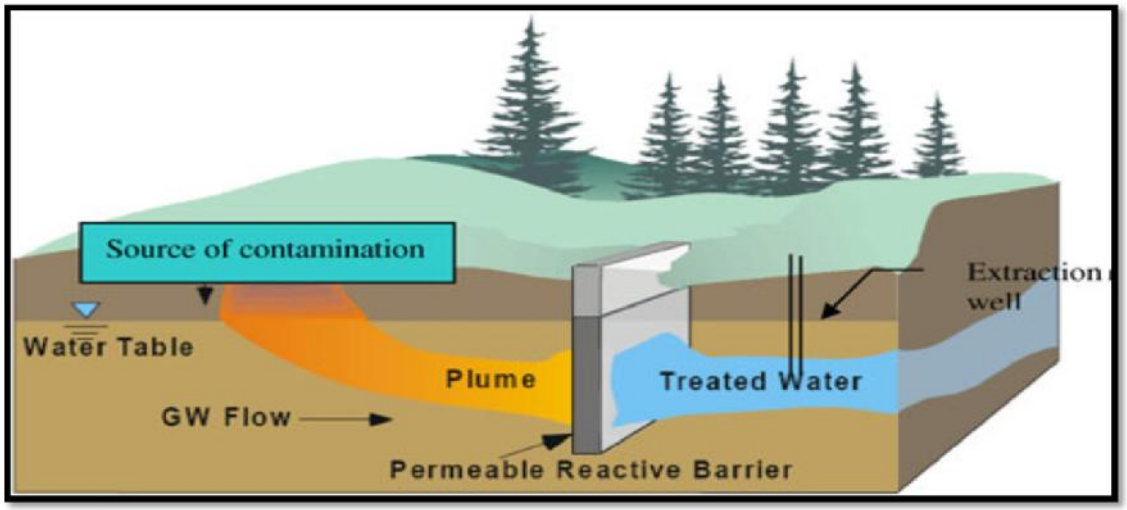
Mid-Level Agricultural Lands

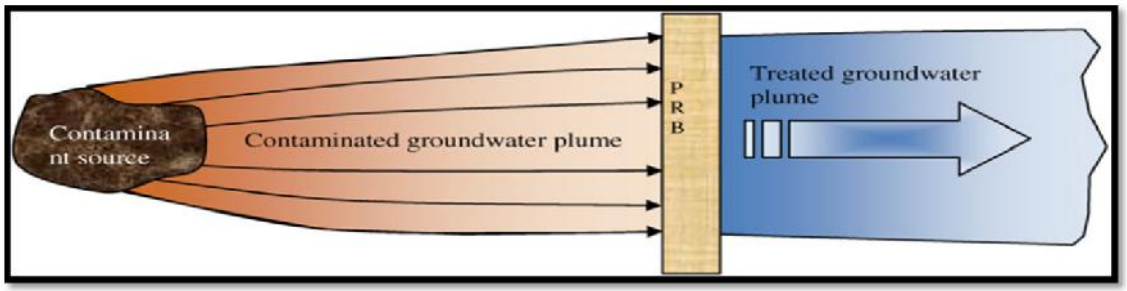
4. Kahili Golf Course Low Impact Design (LID)

- While a relatively small portion of the golf course falls within the project area, there are numerous turf management BMPs that can effectively reduce nutrient stormwater runoff and groundwater pollution on golf courses.

Nutrient Curtain

- The Permeable Reactive Barrier (a.k.a. 'nutrient curtain') is constructed by excavating a trench approximately three feet wide, and four feet deep and long enough to bisect the groundwater moving through the area. It consists of a mix of hardwood chips, sand, sawdust, and activated charcoal (a.k.a. 'biochar').
- This precise mixture converts nitrogen pollution contained in the groundwater into atmospheric nitrogen effectively filtering pollutants from groundwater passing through.
- This process requires no maintenance once installed and has a long effective lifespan because charcoal lasts for hundreds of years when buried in the soil





MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

4. Kahili Golf Course Low Impact Design (LID)

Floating Treatment Wetland (FTW)

A floating treatment wetland can improve the pollution treatment effectiveness of a wet retention pond.

An FTW consists of a floating raft of buoyant material that is deployed on the surface of the pond, on which aquatic plants are grown hydroponically.

Plant roots take up nutrients to support plant growth. The roots hanging down in the water column provide an ideal habitat for denitrifying bacteria.

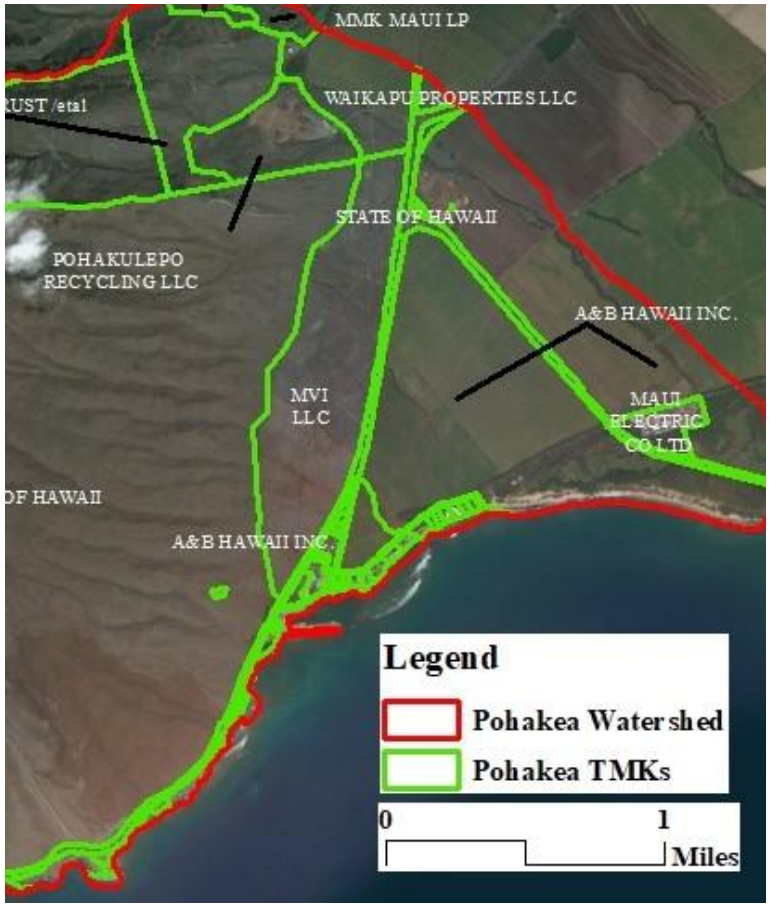
These bacteria remove nitrogen from the water and convert it into nitrogen gas which bubbles out of the water and is released into the atmosphere.

MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

5. Fallow Pastures and the Proposed Spencer Homes Agricultural Subdivision

- The part of the Pohakea Watershed landscape containing fallow pastures located between the base of the West Maui Mountains and the highway form a relatively gently sloped plain.
- This land has significant potential to mitigate sediment transport to the ocean through a number of restoration activities.
- There has been public support for Maui County to acquire this land in an effort to curb additional development and to provide opportunities to address fire and stormwater issues within the watershed.



MANAGEMENT PROJECTS AND STRATEGIES

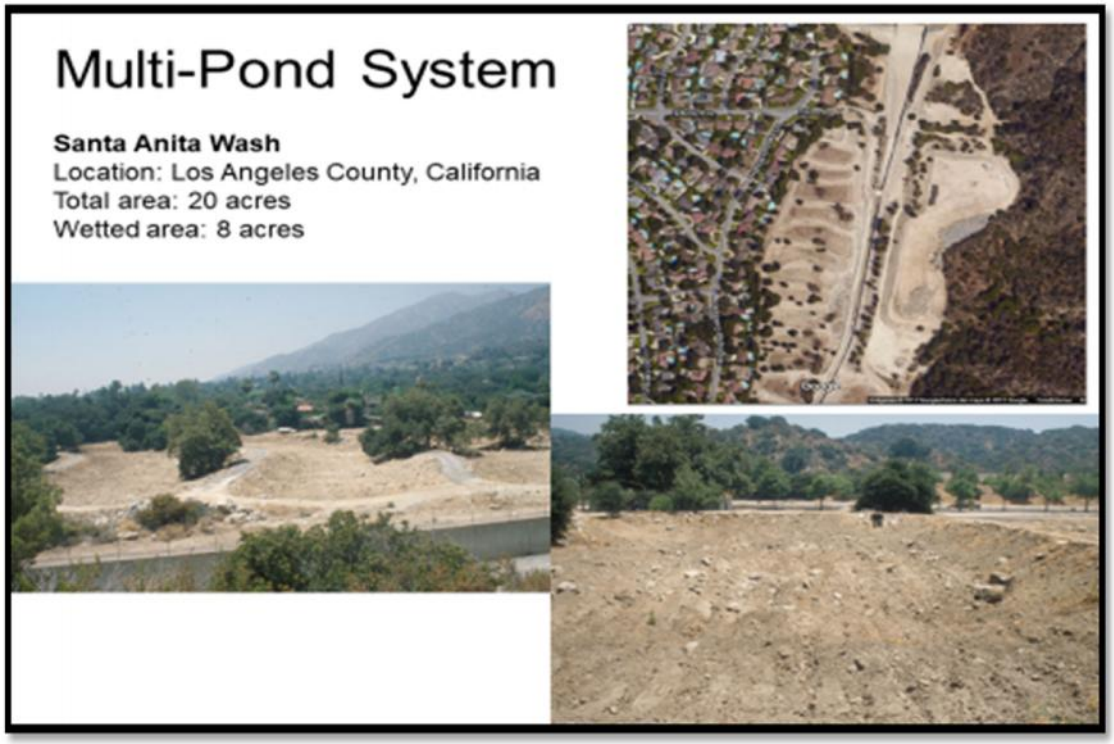
Mid-Level Agricultural Lands

5. Fallow Pastures LID

Multi-Pond System

A dry land multi-pond system such as this example from Los Angeles County, California would be ideal to attenuate high flows coming down the streams in the Pohakea Watershed.

High flows would be diverted out of streams into a series of stepped ponds that would remain dry most of the year.



MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

5. Fallow Pastures LID

Detention Basins in Series

The example to the right is of a proposed detention system from Wahikuli, West Maui that combines a high flow diversion coupled with a series of infiltration basins designed to slow filter and sink stormwater safely into the ground.

MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

5. Fallow Pastures LID

Large Single Detention Basins

- Detention basins function by allowing for high flows from the stream to enter the basin, where sediment settles out as water infiltrates into the ground.
- Overflows pass through a stand pipe and there are additional failsafe mechanisms in case the basin becomes overwhelmed by excessive stormwater.
- Access roads associated with the basin allow for periodic removal of sediment with heavy equipment.
- Large detention basins can be engineered to function as recreational facilities or green spaces.
- Few people visiting the Saturday Swap meet at UH Maui College realize that they are shopping within a stormwater detention and management system.
- This is an excellent example of a multi-use stormwater facility with multiple user beneficiaries.
- Other examples have combined stormwater detention with sports fields, golf courses, public parks, or other green spaces.

MANAGEMENT PROJECTS AND STRATEGIES

Mid-Level Agricultural Lands

5. Fallow Pastures LID

Stormwater Infiltration (Dry) Wells

- This open-bottomed well structure is installed surrounded by gravel and wrapped in a geotextile cloth to prevent fine sediment from clogging the well, which would reduce infiltration performance over time.
- Stormwater is directed into the well where it drains effectively into the ground.
- Infiltration wells can be as simple as a pit filled with rubble or as complex as a prefabricated concrete structure.
- UIC permits are typically required for the installation of infiltration wells.

MANAGEMENT PROJECTS AND STRATEGIES

Commercial and Urban Land

Dirt Lots and Parking Lots

- Dirt parking lots in the vicinity of the harbor should be targeted for improvement. Compacted soil should be revegetated and restored.
- At the very least, they should be improved with gravel, pervious pavers, or another suitable substrate. Ideally, they should be curbed, and all runoff directed into low impact design elements such as bioretention to capture and infiltrate stormwater.

MANAGEMENT PROJECTS AND STRATEGIES

Commercial and Urban Land

Ma‘alaea Triangle Parking Lot

- There is ample space within this lot to incorporate a suite of Low Impact Design (LID) systems to treat stormwater discharging off the parking lot. These include systems such as curb cuts, vegetated bioswales, rain gardens, and pervious paving options.

MANAGEMENT PROJECTS AND STRATEGIES

Commercial and Urban Land

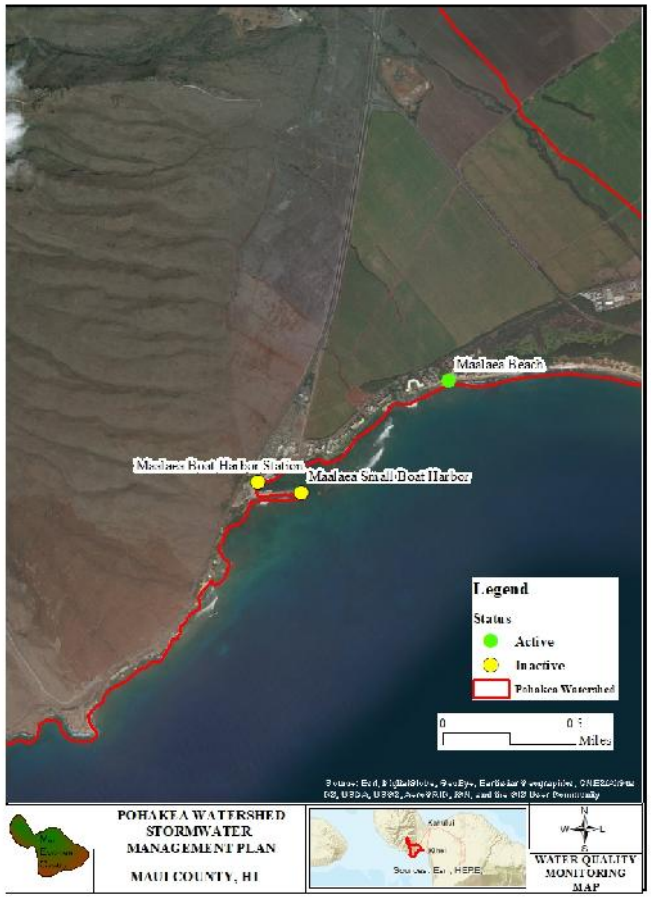
Oysters in Ma'alaea Harbor

- As filter feeders, oysters are capable of pumping large volumes of water through their gills every day.
- This process removes nutrients like nitrogen and phosphorus from the water while improving water clarity, removing algae and promoting other life in the harbor.
- MNMRC is actively pursuing an oyster project in the harbor and Amy will discuss this is detail.

Pohakea Watershed Stormwater Management Projects	
Priority Level	Description
Conservation Lands	
Medium	Unimproved Dirt Road Stabilization/Closure
High	MECO Powerline Corridors/Wildfire Suppression in Conservation Lands
Low	Wind Farm Road BMPs
Low	Landslide Mitigation
Mid-Level Agricultural Lands	
High	Engage with Maui County Regarding Spencer Parcel as Catchment and Greenspace
High	Install Head Cut Monitoring Infrastructure and Engage the Dept of Public Works
Low	Discuss BMPs with the Hawaiian Cement Quarry
Low	Landfill Study
High	Waiheʻe Mauka Ditch and Dirt Road Stabilization
High	Waiheʻe Makai Ditch Cleanup
Low	Maintain Agricultural Roads
Medium	Vegetate Bare Soil Associated with Sugar Cane Fire Breaks
Low	MECO Powerline Corridor BMP Study in Agricultural Lands
Low	Kahili Golf Course Nutrient Catchment
Commercial and Urban Land	
High	Implement Water Quality Monitoring Plan - Especially within Maʻalaea Harbor and West Maʻalaea Bay
Low	Restore Kanaio Stream Pathway
High	Repair Failed Detention Basin
Medium	Gravel or otherwise Improve Dirt Lots at Maʻalaea Harbor
Medium	Maʻalaea Triangle Parking Lot LID Improvements
Medium	Maʻalaea Condominium Injection Well Review (Ongoing)
High	MECO Powerplant Retention Basin (Ongoing)
High	Cesspool Study for Maʻalaea Harbor and the Maʻalaea Place Neighborhood
Low	Maʻalaea Condominium Impervious Surfaces LID Improvements

Water Quality Monitoring Program

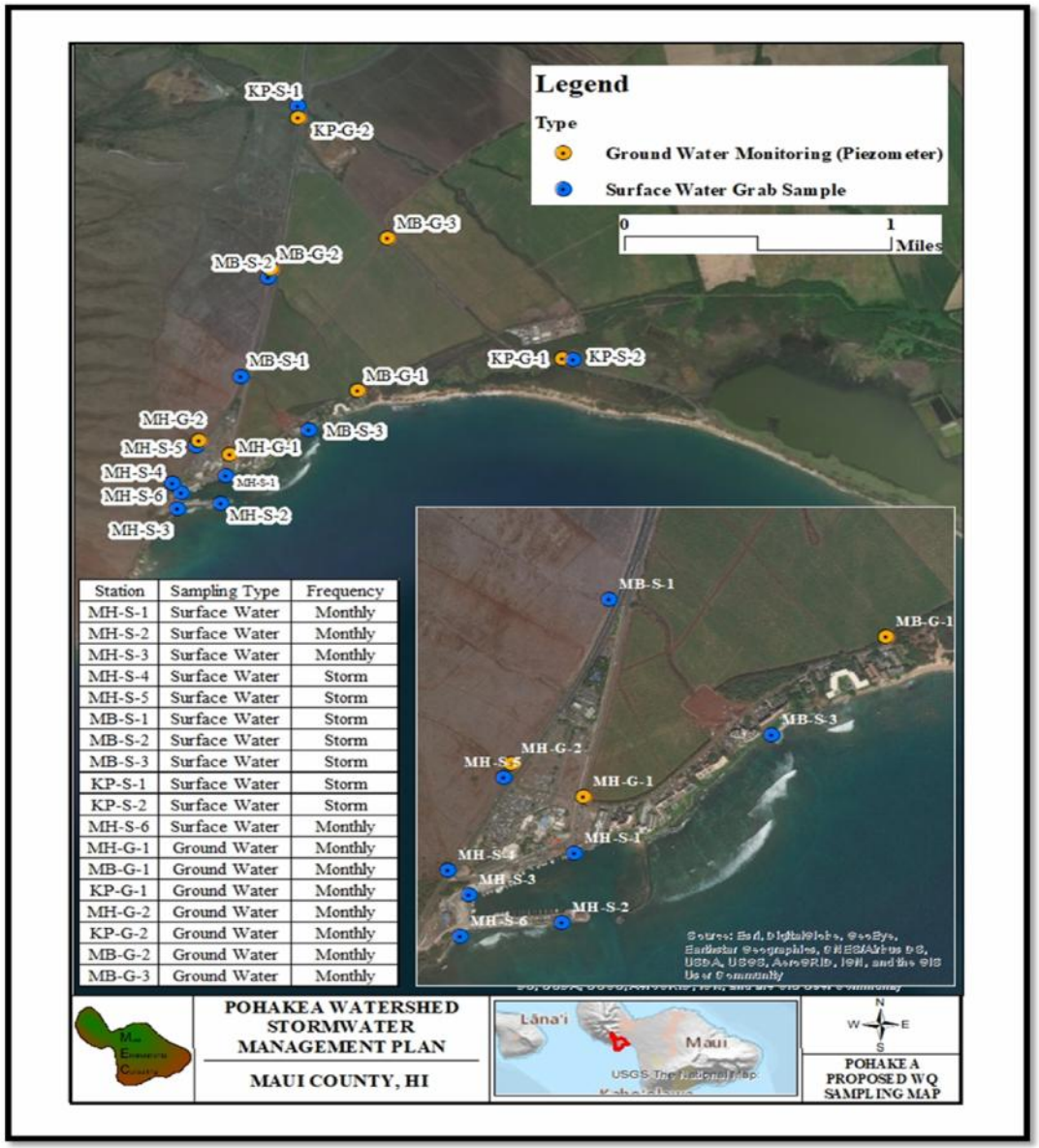
- State standards for water quality are not being met for enterococcus, Chlorophyll-a and turbidity at the one site currently being monitored by the Hawaii Department of Health (DOH) Clean Water Branch (CWB).
- In addition to surface water discharges into Ma'alaea Harbor and Ma'alaea Bay, it has been suggested that significant groundwater discharge occurs in nearshore coastal waters in the form of submarine seeps and springs throughout the coastal portions of the watershed.
- The development of a water quality monitoring methodology provides an opportunity to collect additional data throughout the watershed so that implementation projects can be employed to address water quality problems.



Water Quality Monitoring Program

Surface Water Monitoring Stations

- A total of 11 surface water monitoring stations were chosen to characterize water quality within the Pohakea Watershed discharging into Kealia Pond, directly into Ma‘alaea Bay, and stormwater entering Ma‘alaea Harbor

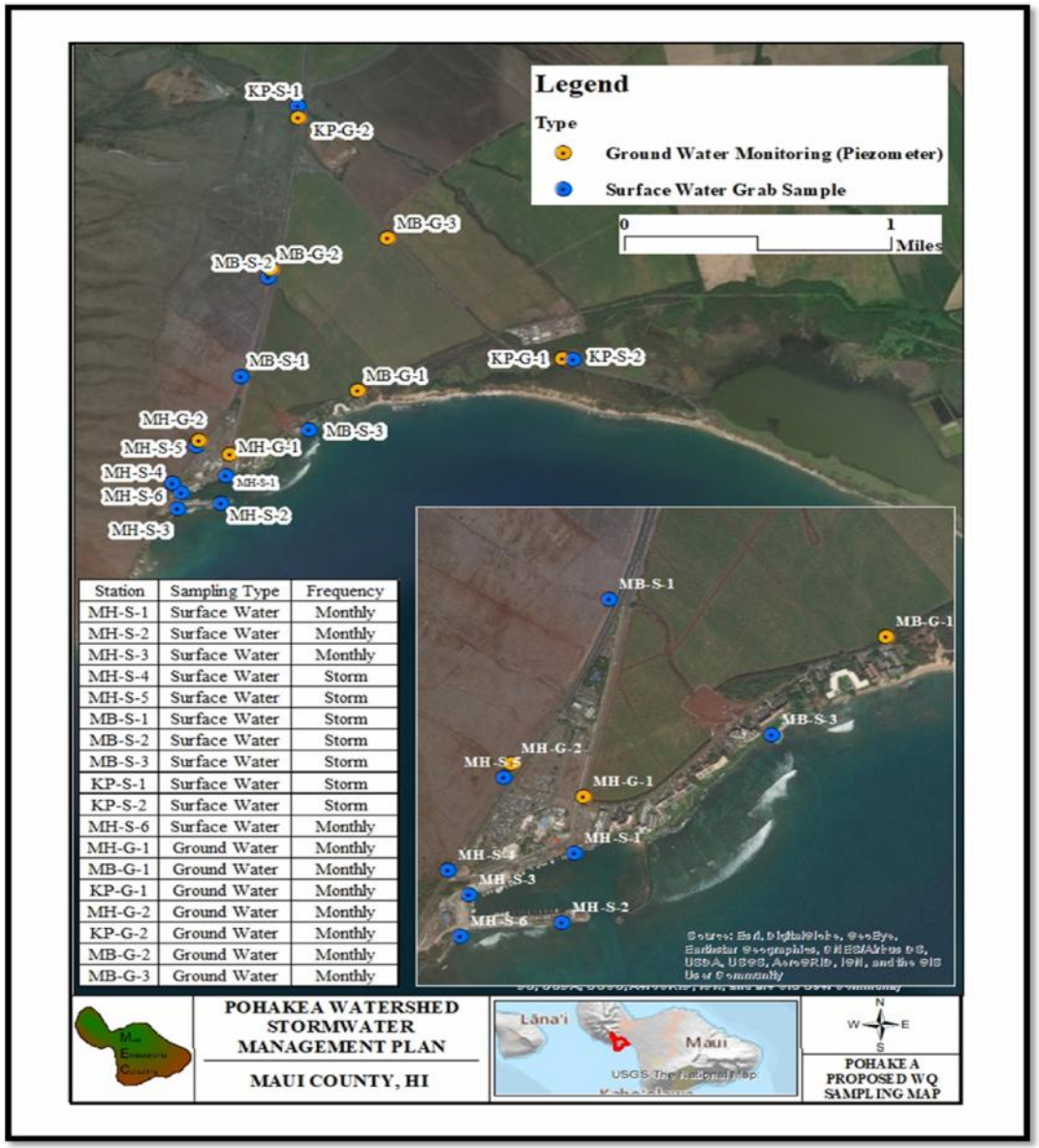


Station	Sampling Type	Frequency
MH-S-1	Surface Water	Monthly
MH-S-2	Surface Water	Monthly
MH-S-3	Surface Water	Monthly
MH-S-4	Surface Water	Storm
MH-S-5	Surface Water	Storm
MB-S-1	Surface Water	Storm
MB-S-2	Surface Water	Storm
MB-S-3	Surface Water	Storm
KP-S-1	Surface Water	Storm
KP-S-2	Surface Water	Storm
MH-S-6	Surface Water	Monthly
MH-G-1	Ground Water	Monthly
MB-G-1	Ground Water	Monthly
KP-G-1	Ground Water	Monthly
MH-G-2	Ground Water	Monthly
KP-G-2	Ground Water	Monthly
MB-G-2	Ground Water	Monthly
MB-G-3	Ground Water	Monthly

Water Quality Monitoring Program

<u>Groundwater Monitoring Stations</u>

- A total of seven ground water monitoring stations have been proposed in order to collect water quality samples of ground water throughout the Pohakea Watershed.
- Ground water samples will be collected via installed piezometers.
- These devices allow for sample collection and ground water level monitoring.
- Placement of these piezometers was designed to collect representative samples from locations in the Pohakea watershed potentially affecting nearshore coastal water quality associated with Kealia Pond, Ma‘alaea Bay, and within Ma‘alaea Harbor.



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MH-S-3	Surface Water	Monthly
MH-S-4	Surface Water	Storm
MH-S-5	Surface Water	Storm
MB-S-1	Surface Water	Storm
MB-S-2	Surface Water	Storm
MB-S-3	Surface Water	Storm
KP-S-1	Surface Water	Storm
KP-S-2	Surface Water	Storm
MH-S-6	Surface Water	Monthly
MH-G-1	Ground Water	Monthly
MB-G-1	Ground Water	Monthly
KP-G-1	Ground Water	Monthly
MH-G-2	Ground Water	Monthly
KP-G-2	Ground Water	Monthly
MB-G-2	Ground Water	Monthly
MB-G-3	Ground Water	Monthly

Water Quality Monitoring Program

SAMPLE PARAMETERS AND FREQUENCY

MEC proposed sampling for the following parameters:

- In Situ Sampling Parameters:

Temperature

Salinity/Conductivity

Dissolved Oxygen

pH

Turbidity

- Laboratory Sampling Parameters:

Total Nitrogen

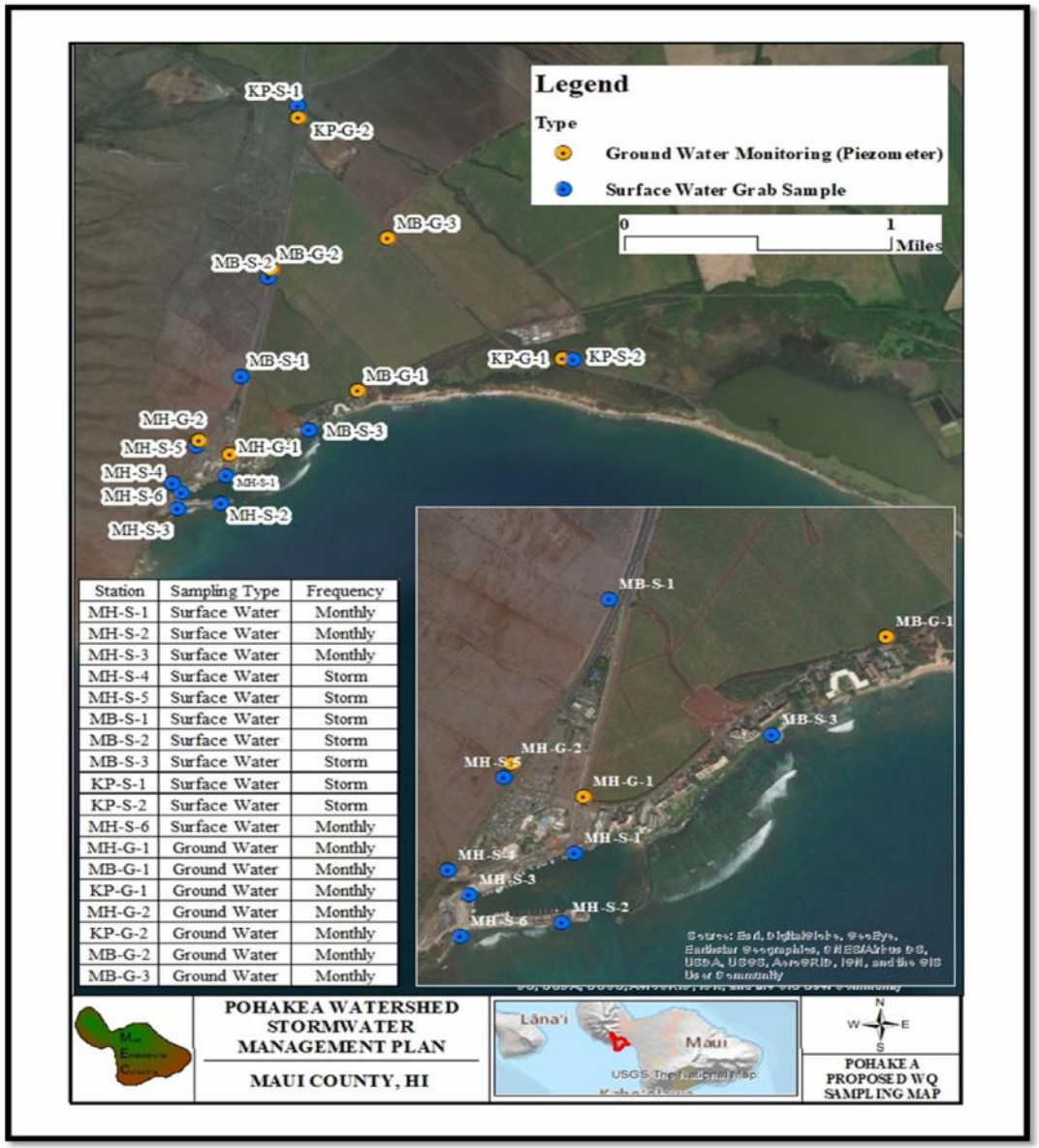
Total Phosphorus

Orthophosphates

Nitrate+Nitrite

Ammonia Nitrogen

Total Suspended Solids



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MH-S-5	Surface Water	Storm
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MB-S-2	Surface Water	Storm
MB-S-3	Surface Water	Storm
KP-S-1	Surface Water	Storm
KP-S-2	Surface Water	Storm
MH-S-6	Surface Water	Monthly
MH-G-1	Ground Water	Monthly
MB-G-1	Ground Water	Monthly
KP-G-1	Ground Water	Monthly
MH-G-2	Ground Water	Monthly
KP-G-2	Ground Water	Monthly
MB-G-2	Ground Water	Monthly
MB-G-3	Ground Water	Monthly

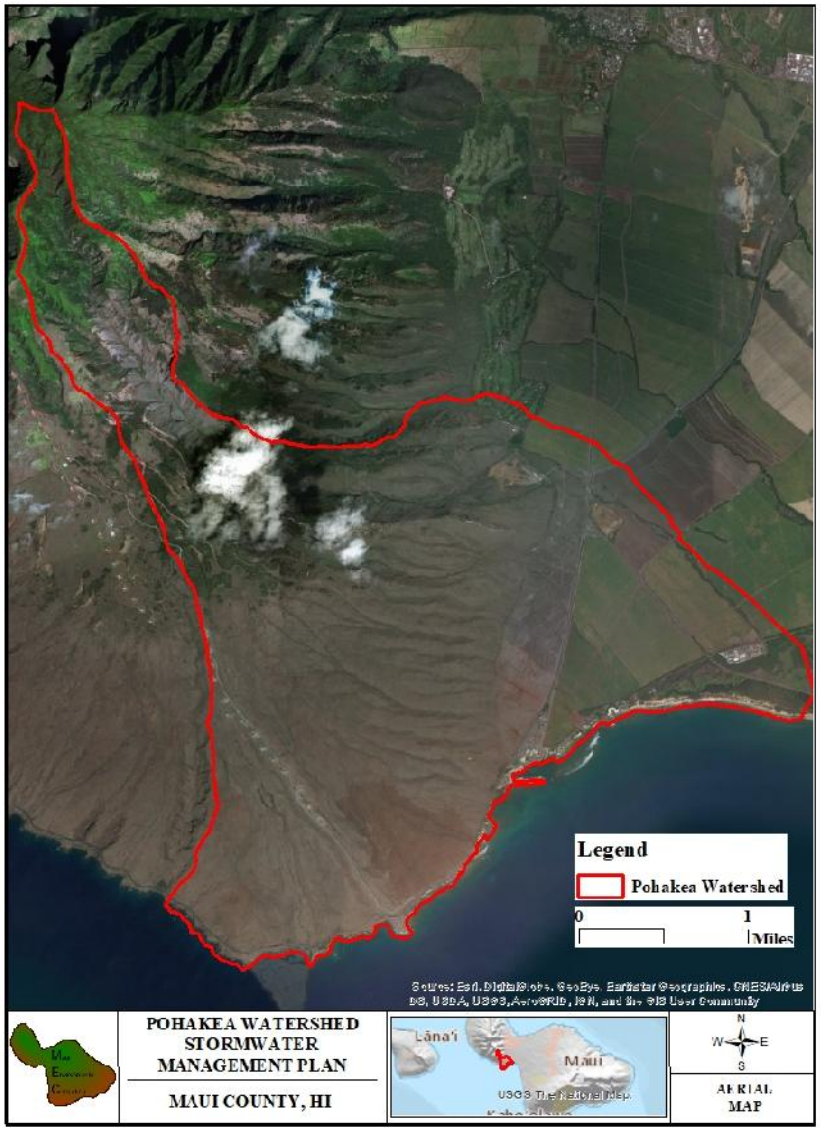
The End!

I would like to thank Maui Nui Marine Resource Council for their continued support of water quality and marine protection.

I'd also like to thank the Maui Ocean Center for hosting this event.

Lastly, thanks to Wesley Crile for helping to develop the Pohakea Stormwater Management Plan.

Questions?


Legend
Pohakea Watershed
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Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
POHAKEA WATERSHED
STORMWATER
MANAGEMENT PLAN
MAUI COUNTY, HI
Lāna'i
Maui
USGS The National Map
N
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