BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Implement Electric Utility Wildfire Mitigation Plans Pursuant to Senate Bill 901 (2018).	Rulemaking 18-10-007 (Filed October 25, 2018)

PACIFICORP'S 2020 WILDFIRE MITIGATION PLAN REMEDIAL COMPLIANCE PLAN

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July 27, 2020

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PacifiCorp d/b/a Pacific Power (PacifiCorp or company) submits this 2020 Wildfire Mitigation Plan Remedial Compliance Plan to address the Deficiency (Guidance-3, Class A) and associated conditions set forth in Resolution WSD-002, made by the Wildfire Safety Division and ratified by the Commission on June 11, 2020.

I. <u>Introduction</u>

Resolution WSD-002 sets forth a number of guidelines for general application to all utilities which have submitted wildfire mitigation plans as part of this proceeding. WSD-002 contemplates different degrees of deficiencies in the wildfire mitigation plans. Class A Deficiencies reflect aspects of the wildfire mitigation plans which the Wildfire Safety Division identified as "lacking or flawed." (WSD-002 at 15.) Resolution WSD-002 identified a single Class A Deficiency – Guidance-3, which was described as a "lack of risk modeling to inform decision-making." PacifiCorp submits this Remedial Compliance Plan (RCP), consistent with Ordering Paragraph No. 7 in Resolution WSD-002, to address the conditions set forth in Guidance-3. This RCP provides greater detail of how PacifiCorp is "leveraging risk models to target the highest risk portion of the grid" (Guidance-3 at A3), and includes a Fire Risk

Conceptual Model provided herein as Attachment A. This filing meets the requirements of the July 17, 2020 Commission-issued Guidance on the Remedial Compliance Plan & Quarterly Report Process Set Forth in Resolution WSD-002.

II. PacifiCorp Will Satisfy All Conditions (Guidance-3, Class A) By Adding Levels of Granularity to Its Risk Modeling.

PacifiCorp welcomes the direction of the Wildfire Safety Division to take wildfire risk modeling to the next level of sophistication. Like the other utilities which submitted wildfire mitigation plans, PacifiCorp participated in the mapping project conducted as part of Rulemaking (R.) 08-11-005 and R.15-05-006.[1] After many years of work and collaboration, the mapping project ultimately culminated in the publication of the state-wide Fire-Threat Map and identification of the High Fire-Threat District (HFTD). As is well understood, the HFTD identifies geographic areas treated as Tier 2, with an "Elevated" wildfire risk, and as Tier 3, with an "Extreme" wildfire risk. For all of the reasons discussed in those previous rulemakings, the risk modeling was consciously designed to identify consolidated geographic areas with defined boundaries. This approach makes sense for many applications, although there are also some downsides to the "broad-brush" approach. From the beginning, there was deliberate discussion regarding this strategy and other risk mapping alternatives. The HFTD designation has been extremely useful in making generalized priority decisions, both from a regulatory perspective (i.e. in making certain requirements applicable to a specific area of wildfire risk) and from an internal perspective (i.e. in deciding where to target certain mitigation programs). Because the general designations are very broad, however, it is also appropriate to recognize how best to

[1] PacifiCorp acted as a territory lead (TL) and submitted numerous adjustments to the modeled results that recognized local knowledge, fire history, impacts to populations, ingress and egress issues and other impacts critical for designating elevated (Tier 2) and extreme (Tier 3) fire threats.

leverage the science behind this work and make more localized risk assessments throughout these generalized areas.

In this context, PacifiCorp emphasizes that prioritizing wildfire mitigation efforts in the HFTD is, and remains, an important mechanism by which risk models have been leveraged. Significant work was done through this mapping project to identify generalized areas of increased wildfire risk. In particular, from a broader perspective, PacifiCorp remains convinced that the Tier 3 designation remains a valid identification of the highest risk portions of the grid within PacifiCorp's service territory. Notably, the demographics of this portion of northern California support the HFTD designations, and the facilities immediately surrounding the communities of Weed, Mt. Shasta, Dunsmuir and Happy Camp are appropriately prioritized by the straightforward application of the Tier 3 designation.

Against this background, however, PacifiCorp agrees with the WSD that more and different types of risk modeling can improve a utility's understanding of the wildfire risk associated with electric facilities. In particular, PacifiCorp agrees that adding layers of granularity in its risk modeling will assist in targeting higher risk facilities within the more generalized tiers identified through the HFTD project.

Other Risk Assessments Applied Through Program Development

To clarify, regarding existing programs under PacifiCorp's 2020 wildfire mitigation plan, certain types of risk modeling and risk assessment approaches have already been used in prioritizing planned work under PaciCorp's existing wildfire mitigation programs. For example, PacifiCorp's pole replacement/reinforcement program integrates two critical risk assessment tools. First, the program integrates pole-specific assessments of (1) ground cover makeup immediately surrounding a pole; and (2) the pole's distance from roads/access points. Second, the program also prioritizes based on pole age, employing the basic logic that older poles reflect greater risk. As another example, the potential public safety power shut-off (PSPS) impact in hardening a section of line is a type of risk assessment used in prioritizing system hardening programs. More detail on these approaches will be provided in response to other Guidance items specific to those programs.

System-Wide Risk Assessments Based on Specific Grid Modules

To better accomplish the "targeted use" contemplated in Guidance-3, PacifiCorp is in the process of assigning risk assessment scores to individual grid modules. In particular, PacifiCorp will apply developed risk modeling methodology to the circuit level and sub-circuit level to address the conditions expressed in Guidance-3. This effort builds upon the grid modularization methodology used in the 2020 wildfire mitigation plan. A module is a section of a circuit that can be isolated by a control operation, or more precisely, as outlined in PacifiCorp's WMP, a module is bounded by a sectionalizing or automated grid control device. Assessing risk at the module level, instead of the broader circuit level, is preferred because protection schemes at the module level can be programmed and adjusted according to risk. In addition, recognition of module level risk is critical to implementing a more surgical PSPS program that impacts fewer customers (and these actions could include manual operations, such as opening switches).

The first step in this process is to leverage prior risk modeling for application at the module level. The core logic in the existing risk modeling remains sound. Modeling general ignition probability and historic fire weather fire spread probability, together with including population density to approximate impact, is the best and primary method to assess general wildfire risk, and this approach serves to establish risk to utility assets, irrelevant of the ignition cause. Accordingly, PacifiCorp will use the Integrated Utility Threat Index (iUTI) to determine the relative risk score of each individual module.[2] Modules with varying iUTI scores are being assessed based on a weighted average proportionate to the portion of the module with any particular iUTI score.

As a next step, PacifiCorp will identify and incorporate additional risk quantification layers to adjust each module's risk score based on the various risk assessment methods. At this time, these layers include (a) historic fire weather fire spread model; (b) tree canopy coverage; (c) available arc energy and short circuit ignition likelihood; (d) utility ignition fault risk; (e) utility fire and equipment; and (f) fire weather risk. As new risks are identified they will be quantified and incorporated into the risk assessment and mitigation prioritization. Each layer is intended to assess an element of wildfire risk, localized to the module level. The specific factors considered in each layer, together with the methodology for weighing those factors, is explained in detail in Attachment A. As a specific example, the tree canopy layer will consider the vegetation directly associated with the subject module. Along these lines, modules with a non-burnable topography under the line will be down-graded accordingly. Similarly, the risk scores for modules with identifiable risk-enhancing features, i.e. tree canopy with high fuel ratings will be increased.

By combining all relevant risk influencers, PacifiCorp plans to assign each module a composite wildfire risk score to reflect the total risk of a utility-related ignition occurring because of a fault on the module.[3] In conjunction with reference to each layer discussed above,

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[2] The Integrated Utility Threat Index (iUTI) is described in detail in the Independent Review Team Final Report on the Production of the California Public Utility Commission's Statewide Fire Map, dated November 21, 2017, at 12-14.

[3] After additional development and experimentation, PacifiCorp will decide whether the score will be a specific numerical value, a ranking, or a more generalized risk assessment category. As more quantification of these risks advances, it is expected that the composite score will be reflected by a numerical value.

the composite risk score will also help PacifiCorp target mitigation programs to the highest risk portions of PacifiCorp's grid. Because of certain design goals, access limitations, and other factors not specifically calculated, a higher composite score does not necessarily mean that the module will always receive priority over a module with a lower risk score. For example, it would often not make sense to prioritize a module for certain types of work in one year if the same module was scheduled for conversion to covered conductor in the following year.

Access to the powerline is considered in this stage of the assessment for multiple reasons. Reduced access logically correlates to more limited situational awareness as well as more difficult suppression; moreover, reduced access also strongly correlates with powerlines located within and directly over wildland vegetation (versus other types of landscapes, such as landscaped residential yards), which reflects greater risk. Other factors include difficult terrain, significant elevation change, prevalence of tall trees in the right-of-way, and areas with increased wind exposure. Nonetheless, for most programs, each of the layers for module risk scores will be critical inputs in prioritizing mitigation efforts.

Finally, each module is being separately considered for its relative PSPS impact. Factors in this risk assessment include (i) the total number of customers who would be impacted by de-energization of the module; (ii) the number and type of critical facilities which would be impacted by de-energization of the module, including an assessment of back-up generation capabilities; (iii) the number and type of access and functional needs customers who would be impacted by de-energization of the module, including an assessment of back-up generation capabilities; and (iv) the economic impact to commercial customers if the module is de-energized. In each case, the number of customers is the sum of those customers directly served off the module as well as all downstream customers.

Unlike the layers discussed above, the PSPS impact layer is not intended to reflect the wildfire risk of ignition associated with the module, but rather its community impacts. Specifically, the PSPS impact layer helps PacifiCorp prioritize mitigation efforts. System hardening and other mitigation activities which reduce the wildfire risk associated with a module can justify strategies to minimize the PSPS impact of the module, by either eliminating the module from PSPS consideration or by reducing the probability that de-energization of the module would ever occur. Additional detail on how this layer is applied will be discussed in responses to other Guidance items focused on PSPS.

New Real-Time Risk Modeling Approach

PacifiCorp is participating in a pilot program to assess the value of a different risk modeling approach focused on the variable risk at a given point in time. Prior risk modeling has focused on the total risk over time. For most mitigation activities, ranging from system hardening to vegetation management, comprehensive risk modeling makes sense because the goal is to reduce total risk at all times. Certain mitigation strategies, however, are responsive to real-time conditions. Above all, the cost-benefit analysis inherent in the determination of whether to implement a PSPS is highly dependent on the evaluation of wildfire risk at a particular point in time. Other strategies, such as the use of wildfire settings on protective devices, can also factor short-term risk analysis. For these reasons, PacifiCorp is exploring emerging risk modeling technologies which use updated fire weather conditions to model ignitions from locations on the grid, as being advanced through the California Energy Commission's Electric Program Investment Charge (EPIC).[4] This project is developing a suite of utility fire tools including

[4] This grant-funded project was initially titled "Next Generation Wildfire Model Project," and is now renamed Pyregence. PacifiCorp continues to support this effort and is currently acting as a technical advisory committee member for the project.

advanced real-time fire simulation tools intended to support decisions regarding utility operations, including PSPS.

III. Conclusion

PacifiCorp is committed to use advanced risk modeling to target its wildfire mitigation strategies at the highest risk portions of the grid. Existing prioritization procedures use multiple wildfire risk assessments. Building on prior work and a risk modeling approach based on sound wildfire science, PacifiCorp is now adding new levels of granularity to its wildfire risk assessments by assigning wildfire risk scores to individual circuit sections. PacifiCorp is also participating in a pilot to evaluate the value of real-time risk modeling. Collectively, these efforts sufficiency resolve the identified deficiency and satisfy the Guidance-3 conditions of Resolution WSD-002.

Respectfully submitted,

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July 27, 2020

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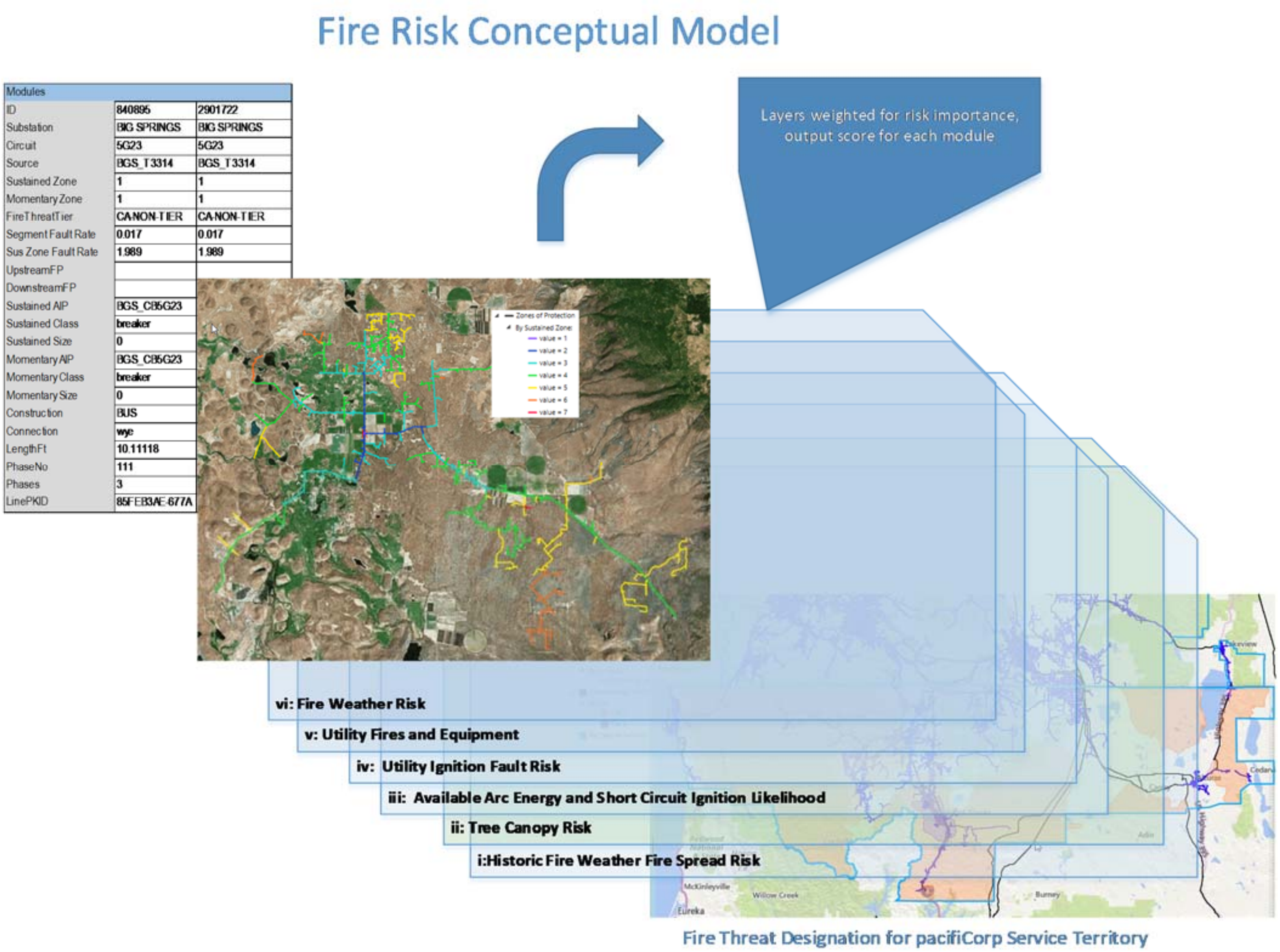
Attachment A

Attachment A

Fire Risk Conceptual Model

PacifiCorp's strategy for fire risk modeling is intended to serve as a refreshable foundation establishing quantification methods for a variety of influencers that should be considered to calibrate risk within any given module within its electrical network. A module is a subsection of a circuit with control, either programmatically, automatically or manually-effected. As such it is the smaller granule against which any locational risk should be considered. Integration of all risks, using rationalized weighting factors will serve to provide rankings for each module that will be used to prioritize efforts for wildfire mitigation actions. The individual layers and model development parameters are outlined in the subsections below. The relationship between layers can be visualized as follows:



The timeline below identifies the current development of the model:

Risk Modeling for Wildfire Mitigation Prioritization		May	June	July	August	September	October	November	December	January
9/30/2020	Historic Fire Weather Fire Spread Model									
8/30/2020	Tree Canopy Coverage									
9/30/2020	Available Arc Energy and Short Circuit Ignition Likelihood									
9/30/2020	Utility Ignition Fault Risk									
8/30/2020	Utility Fires and Equipment									
10/30/2020	Fire Weather Risk									
11/15/2020	Assemble data									
11/30/2020	Evaluate highest risk areas									
11/30/2020	Compare against current mitigation priorities									
12/15/2020	Adjust prioritization schedule where appropriate									
1/15/2021	Summarize plans, current status, risk areas into WMP									

Further, on an annual basis it is expected that the following refresh cycle will be required:

Risk Modeling Refresh Process	
Annually	Evaluate the risk influencers to be quantified for the upcoming period
Annually	Develop the method for calculating the influencer for each risk influencer
Annually	Establish weighting for each influencer relative to some identified objective
Annually	Calculate module scoring for the combined influencers
Annually	Stress test the results against objective criteria
Annually	Modify calculation or weighting as necessary
Annually	Finalize the rating/ranking for each module
Annually	Compare against prioritization efforts for WMP, including PSPS operations
Annually	Modify prioritization where appropriate
Annually	Communicate the results of the risk scoring method
Annually	Archive results with appropriate version details
Ongoing	Review other risk influencers for inclusion in future assessment periods

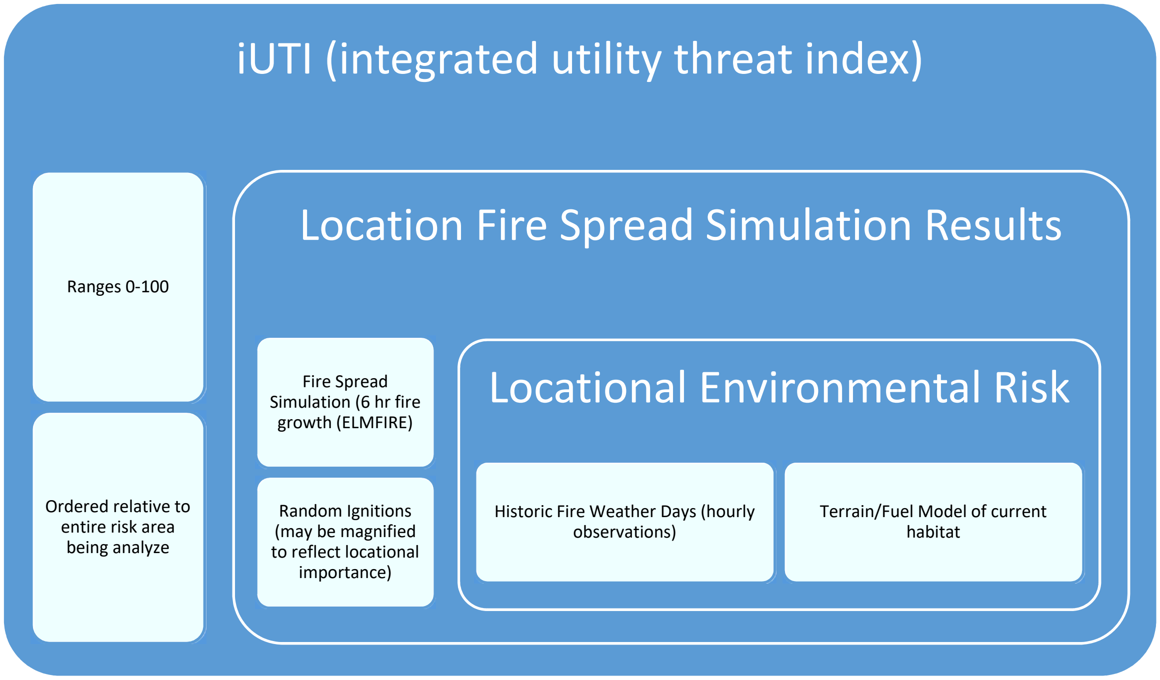
A. **Fire Risk Influencer:** Historic Fire Weather Fire Spread Model

Risk Layer Objective: In order to provide a durable measure of fire spread, create a method to use fire weather days' climatology across a broad area and utilize probabilistic methods to substantiate the certainty of fire (with those historic fire days) at a specific location, with the specific known fuel matrix, and the ancillary populations that would be impacted in that location.

Concepts Underlying Rendered Data and Layer: Using elevated fire weather days, rationalize those to gauge from 1-100 the certainty that if historic climatology is experienced on current habitat,

Primary Driver: Implement wildfire mitigation strategy in areas with elevated or extreme fire risk based upon historic fire weather

Diagram of Relevant Data Establishing Quantification



Testing Validation:

- Ground-truth against historic perimeters,
- Validation against other fire risk outputs

Current level of granularity & impact on measures:

- Landfire data relatively outdated (20 m gridded data)
- Uses Anderson fuel models
- Fire weather history (days where FFWI > 50) from 1989-2017 (at 30 m resolution)
- Recent fire weather days not part of current model
- Inclusion of access and other unmodeled aspects result subject matter expert assessment
- Computationally intensive to produce unindexed results; SME-intensive to produce indexed results

Assumptions inherent in the model:

Past fire weather climatology is similar to future climatology on fire weather days

Technologies Required: Extensible geographic model including terrain, landfire, weather and population

Triggers to Refresh:

- Refreshed landfire data
- Additional fire history where climatology differs substantially from historic dataset
- Substantial changes in population patterns (shifts from an area or to an area, not gravity growth levels)

- Need to extend model to geography not previously modeled
- Climate change resulting in variations in where specific climatology might be experienced
- Changes in machine and human processing which would afford a more routine cycle

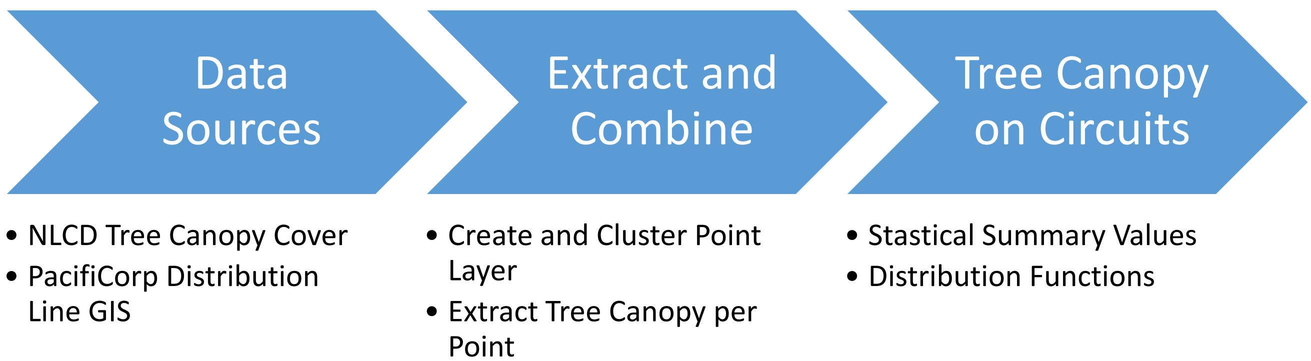
B. **Fire Risk Influencer:** Tree Canopy Coverage

Risk Layer Objective: Determine extent of tree cover along circuits.

Concepts Underlying Rendered Data and Layer: A point layer was created from PacifiCorp Distribution Line GIS files with 30m spacing. The point layer was clustered to avoid oversampling at line intersections. Data was extracted from the NLCD Tree Canopy Cover raster layer at each point, then aggregated per circuit or zone of protection segment. This provides distribution functions and statistical values for the tree canopy cover along each circuit.

Primary Driver: Find locations with highest demands for vegetation maintenance.

Diagram of Relevant Data Establishing Quantification



Testing Validation: Compare to other vegetation cover data, including other public data and PacifiCorp remote sensing data. Compare with vegetation outage rates by location.

Current level of granularity & impact on measures: Base data has 30m^2 resolution. Extracted data maintains 30m resolution along lines. Tree canopy coverage alone is likely not the strongest driver for fire risk, though the risk of trees falling onto lines should correlate with tree density.

Assumptions inherent in the model:

- Techniques used by NLCD for the base data layer are consistent and accurate.
- Higher tree canopy correlates to more trees and more risk.
- 30m^2 resolution is sufficient to capture relevant trees. Based on spot checks, this appears to be generally true in rural/less developed areas but not consistently true in urban areas.

- Position errors are random and can be removed through statistical sampling. It should be noted that aggregated distributions are generally multi-modal, not Normal (Gaussian), and techniques based on Normal distributions should be avoided, including the 'mean' value per Circuit or segment.

Technologies Required: Currently using GIS processing, high performance clustering (density based), scripted data aggregation and analysis. Technique/technology changes may be needed if frequent updates are required.

Triggers to Refresh: Republishing of NLCD Canopy Cover Layer, anticipated at 3-5 year intervals. Major changes to PacifiCorp asset locations.

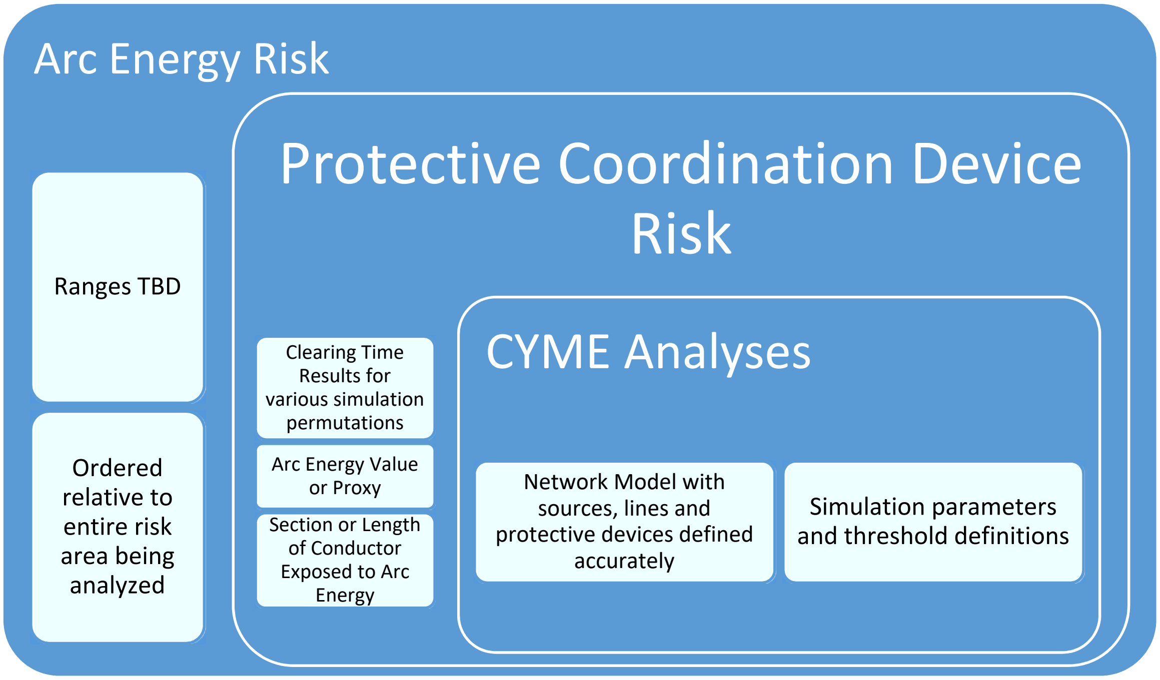
C. **Fire Risk Influencer:** Available Arc Energy and Short Circuit Ignition Likelihood

Risk Layer Objective: Throughout the distribution system, quantify and rank the likelihood of ignition from short circuit events involving ground. The metric will be associated with poles of significance, which are modeled as nodes in CYME.

Concepts Underlying Rendered Data and Layer: Available short circuit current due to ground faults (LG, LLG, LLLG) varies throughout the distribution system, and can be estimated by the CYME model. The time for a clearing device (fuse, recloser, breaker, etc.) to clear such a fault can also be determined from the model. Arc Energy is a composite of the current and the time to clear, and is measured against the amount of conductor exposed to the arc energy. With other variables held constant, ignition risk from short circuits is more likely when current is high, and when clearing time is long. Auxiliary parameters from this analysis may also be helpful. For example, conductor damage relating to short circuit events, and customer count beyond the protective device. With additional modeling time, short circuit events involving multiple distribution or transmission conductors could be analyzed.

Primary Driver: Identify areas where system improvements (including by not limited to additional protective devices, reconductors) are warranted in order to reduce ignition risk, and create an additional data layer to combine with other information, such as ground fuel and climate history, in order to prioritize problems areas.

Diagram of Relevant Data Establishing Quantification



Testing Validation:

- Verify long clearing time devices and settings (especially reclosing parameters) with area engineer
- Spot check other devices and settings with area engineer, PROSPER records
- Look for outliers in 'impedance to source' values and follow up for verification
- Where possible, short circuit information from real events should be compared against forecast

Current level of granularity & impact on measures:

1. Asset location (poles, lines, devices) is substantially correct in GIS/CYME.
2. Asset definitions (type, material, rating) are poor and will require manual clean up before results are useful
    a. Lines with common neutral are problematic, but may not move the needle for results
    b. Contributions from DER have some unknowns, and assumptions may be used
3. Source impedance values (substation low side source equivalent) are acceptable in most locations, but lacking in special cases (single phase source, etc.) where manual intervention will be required
4. Feeder protection (breaker TCC) and line recloser settings are lacking in most locations and will require manual population
5. Currently no locational data on earth resistivity is included in the CYME model. Generally 100 ohm-meters is used, but this value could be changed.
6. Overall, the protective device settings are the largest gap likely to hinder usable results in the short term.

Assumptions inherent in the model:

1. CYME algorithms are trustworthy for short circuit analyses.
2. Most erroneous data in small sections of the network model will not have substantial impact on the measure
3. Reporting and correcting unknowns and default values in the network model will be sufficient to provide a workable model for simulations

Technologies Required: The inaugural work can be performed in CYME software without additional technologies. Output and combination of results with other measures is expected to be achievable with existing tools.

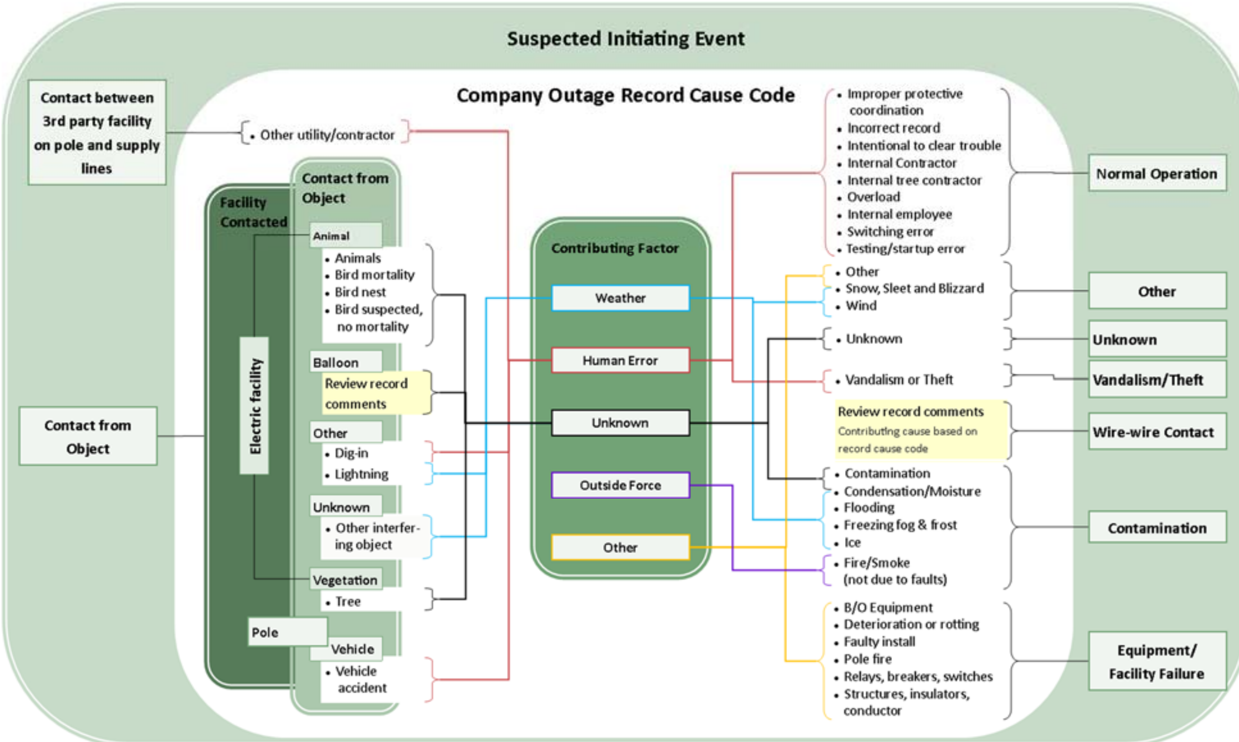
Triggers to Refresh:

- Completed reliability/protection projects
- Completed load growth/system reinforcement capital projects (also referred to as N7 or N8 projects)
- Over time, CYME batch analysis could be set up to generate updated results, possibly using the capabilities of CYME Server

D. **Fire Risk Influencer:** Utility Ignition Fault Risk

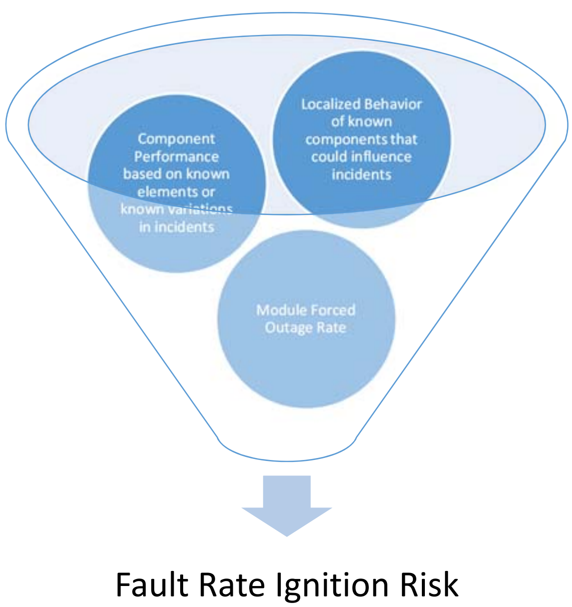
Risk Layer Objective: To review and assess the relationship between outages and ignitions, augmenting outage fault rates with specifics regarding types of components and outage causes.

Concepts Underlying Rendered Data and Layer: The dataset supporting the analysis is housed in Prosper and analyzed consistent with methods developed in response to the CPUC's Wildfire Safety Division's Wildfire Mitigation Plan Template requirements. Suspected Initiating Events hone in on subtypes of outages and components with varying rates of ignition probabilities (as depicted in Tables 18.a-d. This dataset forms the basis for module fault rate/outage type/component factors. The methodology for segmenting the data to establish suspected initiating events is shown below.



Primary Driver: Implement wildfire mitigation strategy in areas where outage history, causes and equipment result in elevated outage ignition risks.

Diagram of Relevant Data Establishing Quantification



<u>Testing Validation:</u> Validation of outage segmentation and elevated risk modules back-cast against reliability performance. Outages included based on cause or component that they correlate.

<u>Current level of granularity & impact on measures:</u> Electric topology is based upon modules, however limitations of line elements within modules may not be comprehensive and will be derivative of "rule sets" established for estimation purposes, i.e. service stirrups are not a modeled feature, nor is an overhead splice.

<u>Assumptions inherent in the model:</u>

- Outage causes are correctly captured to support segmentation
- Certain unrecorded equipment type may be inferentially identified in a module and the assumptions for such associations are correct
- Changes in circuit topology and environmental impacts can yield substantially different incident rates from the suspecting initiating events
- Sub-module changes can result in substantial variations in ignition risk over time and may not be easily back-cast for comparison purposes

<u>Technologies Required:</u> PROSPER, GIS/GREATER, SQL, other software tools are likely

<u>Triggers to Refresh:</u> Annually

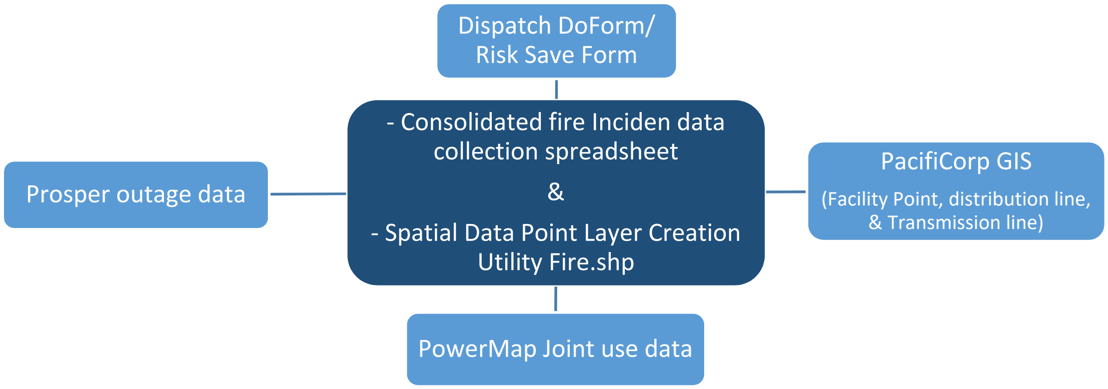
E. **<u>Fire Risk Influencer</u>:** Utility Fires and Equipment

<u>Risk Layer Objective</u>: To review and compare utility caused fire details and locations, in an effort to determine what causes and risks contribute to utility equipment ignition. The information can be used to determine any trends which may occur when analyzed with additional fire risk influencers. This data will help to determine where addition system and equipment risk exist to drive facility locations upgrades and placements for protective equipment.

<u>Concepts Underlying Rendered Data and Layer</u>: A dataset in an excel spreadsheet of utility caused fires. Fires are reported from the PacifiCorp Claims Department, with additional detailed information added by Network performance using data sources listed below.

<u>Primary Driver</u>: Implement wildfire mitigation strategy in areas where at risk equipment exists.

<u>Diagram of Relevant Data Establishing Quantification</u>



Testing Validation: Review and compare form data provided by Dispatch and Claims to lat long location, equipment location, and Prosper outage details.

Current level of granularity & impact on measures: Data location based on GIS equipment location at the time of the incident.

Assumptions inherent in the model:

- Equipment type, location, and environment drives at the time of the event can cause equipment ignition.

Technologies Required: SharePoint site, Microsoft Excel, ESRI ArcMap, Proper, and Google Maps

Triggers to Refresh: New recorded utility equipment fire incident.

F. **Fire Risk Influencer:** Fire Weather Risk

Risk Layer Objective: Using the historical weather during wildfires create a layer that can gauge the current probability of a fire growing to an extreme size given an ignition event. This layer is the combination of historical wildfires, current weather, historical long term drought indexes, vegetation datasets, visual greenness as measured from NASAs MODIS satellite, and forecasted weather.

Concepts Underlying Rendered Data and Layer: The main goal is to identify the combination of weather, vegetation, and fuel conditions which are necessary for extreme wildfires to occur. The first step in this process is to establish the base environmental conditions in each ecological sub-region which are correlated with the existence of these extreme fires. Once these base conditions are established we can then quantify exactly how much the current state (of the weather, vegetation, and fuel) is above (or below) those base conditions. That relative measurement provides us a quantitative understanding of the wildfire risk in the regions surrounding our infrastructure.

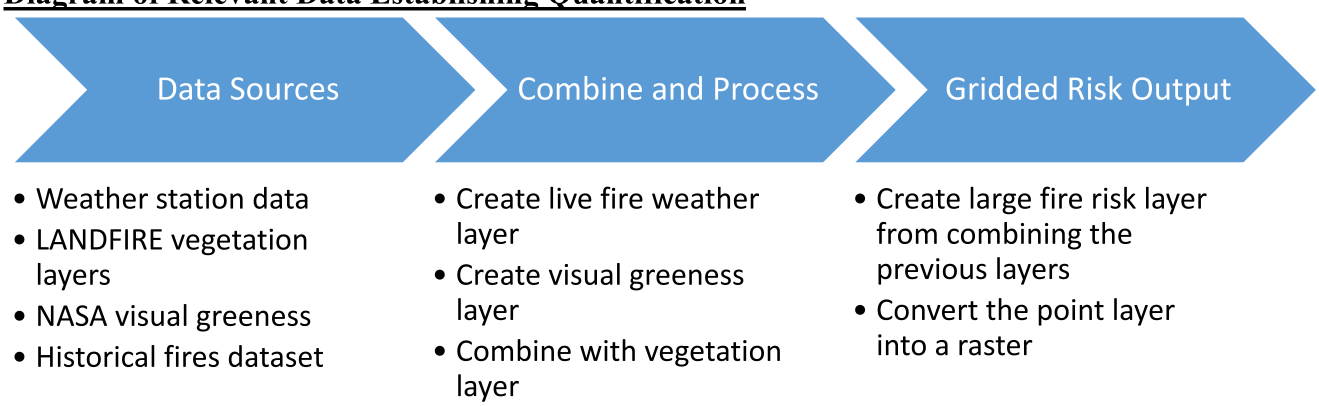
To do this we need to build a probabilistic model which can incorporate all of these aspects into one final large fire probability. We can try to correlate all aspects at once, or we can investigate them independently and join them in the end. For example, we can look at how the weather, vegetation, or fuel aspects are correlated with extreme fires without considering the others. In that situation we would create a risk score for each aspect and at then combine the three risk scores at the end through a final model.

No matter what avenue is chosen the predictions of this model need to be calibrated to the actual frequency of events in the real world. For example, if the model predicts 0.05 then that should mean that 5% of the time that these conditions were present there was an extreme fire in the area. Additionally once we have this risk probability we can quantify the hours that each circuit, zone, or line exceeds a certain threshold. We can then combine the hours spent in an elevated risk state with the length of each line segment to allow us to quantify the additive extreme fire risk contribution from each line segment. This would allow us to systematically quantify the extreme fire risk associated with each circuit, zone, or line assuming an ignition occurs at that point.

One caveat - to get an understanding of the actual wildfire risk due to a piece of equipment we would have to combine the large wildfire risk layer with an ignition probability risk layer. Since the formation of a large wildfire needs an ignition event, this layer is just one aspect of the risk equation.

Primary Driver: Identify locations in real time which pose the greatest extreme wildfire risk given an ignition at that location.

Diagram of Relevant Data Establishing Quantification



Testing Validation: We can use historical wildfires to identify the conditions which are highly correlated with extreme fire growth. Another option is to use simulation outputs of wildfire spread and correlate the final fire sizes with the inputs used.

Current level of granularity & impact on measures: The NASA visual greenness measurements have a resolution of 500m, the LANDFIRE layers have a resolution of 30m, and weather station measurements are at a point. The hardest data to deal with would be the weather stations, but we can employ a method called kriging. Kriging is a statistical methodology that can be thought of as a sophisticated form of interpolation which can consider both differences in location and elevation. This is not perfect solution, but it gives us a better understanding compared to the point measurement. In general it would make sense to pick a common resolution like 90m and get all of the layers to the same scale.

Assumptions inherent in the model:

- The LANDFIRE vegetation layers are representative of the vegetation in real life.
- Visual greenness is strongly correlated with life fuel moisture. This assumption is strongly supported by past research[i].
- The visual greenness measurements are accurate and free from errors.
- Correlations identified between extreme wildfires and weather, vegetation, and fuel conditions are causal and not purely coincidence and they will continue into the future.
- The fuel conditions can be established by calculating the fuel moisture using weather station data.

Technologies Required: Computing system, Python, and computational cluster and fire modeling software if simulations are to be used.

Triggers to Refresh: Fire weather layer is updated hourly as new data comes in. The visual greenness layer is updated every two weeks as updated values are released. The vegetation layer is updated when LANDFIRE releases new data.

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[i] B. Myoung, S. H. Kim, S. V. Nghiem, S. Jia, K. Whitney, and M. C. Kafatos, "Estimating live fuel moisture from MODIS satellite data for wildfire danger assessment in Southern California USA," *Remote Sens.*, vol. 10, no. 1, 2018.