



**ADDENDUM #2
Parks and Open Space
Cal-Wood Fire Infrastructure Protection Design-Build Project
RFP# 7221-21**

April 5, 2021

The attached addendum supersedes the original Information and Specifications regarding RFP# 7221-21 where it adds to, deletes from, clarifies or otherwise modifies. All other conditions and any previous addendums shall remain unchanged.

ATTENTION BIDDERS:

The submittal date and time is amended and extended from April 8, 2021 at 2:00 p.m. to **April 12, 2021 at 10:00 a.m.**

Please note: Due to COVID-19, BIDS will only be accepted electronically by emailing purchasing@bouldercounty.org.

1. Question: If the same staging yards are going to be used for the aerial mulching and the work for this project can the same CDPHE Colorado Discharge Permit System (CDPS) Construction Stormwater permit and Boulder County Stormwater permit be used, or will the contractor for this project need to pull their own permit?

ANSWER: The Contractor/Design-Build team for this project as Operator will need to pull separate CDPS Construction Stormwater and Boulder County Stormwater Quality permits. While the same staging areas between the two EWP Contractors might be useful and could be coordinated, this is not assured since the focus areas of work will be so different. The County mentioned it as an option to consider in order to reduce overall ground disturbance.

2. Question: Can you possibly move the submittal due date?

ANSWER: The submittal date and time is amended and extended from April 8, 2021 at 2:00 p.m. to April 12, 2021 at 10:00 a.m.

3. Question: Can the structures be made of metal or other man-made materials or is it preferred to use native on-site materials?

ANSWER: We expect that the nature of the risk and design analysis will determine the type of material utilized in the design. Low-toxic and non-toxic materials are required so submittals will be reviewed per toxicity standards included in the original RFP (page 13) and Attachment S. Native on-site materials can be considered to reduce project costs, when and where allowed by permits.

4. Question: When is the anticipated award date and NTP?

ANSWER: The anticipated award date is April 20, 2021. A sample Pre-Authorization of Work Agreement is included with this Bid Addendum and is referenced on page 18 of the original RFP. Design work could begin within 7 days of the award date once the Pre-Authorization of Work Agreement is signed, weeks earlier than the Contract NTP.

Additionally, a sample Sensitive Data Agreement is also included in this Bid Addendum since this might impact the Contract NTP date. The Contract is expected to be in place 4 to 5 weeks after the award date.

5. Question: Are the existing debris/mud flow models sufficient in extent and detail to inform the design of protection measures?

ANSWER: The County cannot answer this as the Design-Build team (Contractor) will be responsible for the level of modeling and data analysis conducted to inform their engineering designs. The County will provide all models and model contact information that are known and available to the County at the time of the pre-authorization of work agreement and later into the Contract period.

- The Colorado Water Conservation Board (CWCB) Technical Assistance (TA) Team partner Enginuity provided initial post-fire hydrology modeling efforts that indicate post fire ratios to pre-fire flow events: <https://enginuity.maps.arcgis.com/apps/View/index.html?appid=fa441fc9de274effb0a62799ab328f17>
- The USGS debris flow model inputs are explained in the Slides attached to this Bid Addendum 2, and furthermore:

- You can download all of the hazard assessment geospatial data at the following link:
https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=361
- Scientific background and references for USGS models:
https://www.usgs.gov/natural-hazards/landslide-hazards/science/scientific-background?qt-science_center_objects=0#qt-science_center_objects
- The CWCB TA Team partner CFRI provided gross and net hillslope erosion modeling assistance <https://arcg.is/1SWDL00> and <https://drive.google.com/drive/folders/1B3LIPaqRTIRC4L4e-ixF2o1kGp2sPif9?usp=sharing>

The County will work with the selected Design-Build team to fill in other modeling gaps if we can as identified by the Design-Build team, but the Design-Build team should not rely on additional modeling to be provided by the County or other partners in a timely manner necessary to the completion of the Design and Design Implementation by the Design-Build team.

6. Question: Does the County expect the selected Contractor/consultant to perform additional debris/mud flow modeling?

ANSWER: The Design-Build team will be responsible for the level of modeling and data analysis conducted to inform their engineering designs.

Additional Information from Bid Addendum No. 1 question, additional data on pre-fire hydrology: Peak flows from CHAMP model.

The flows used in the CHAMP model are freely available from FEMA as part of the Preliminary FIS (Flood Insurance Study). For locations of the flow change locations on the CHAMP website: go to <https://coloradahazardmapping.com/story?county=38e502ea-bd6d-4664-bfb1-de94f59309a7> and click "Hydrology" in the top menu bar. The HEC-RAS model is available upon request.

Screenshots from the FIS:

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	1% Annual Chance Plus	0.2% Annual Chance
Fourmile Creek	Upstream of the confluence of Todd Gulch	7	148	298	460	668	735	1,341
Geer Canyon	At confluence with Lefthand Creek	7	147	321	515	762	1,273	1,560
Geer Canyon	Downstream of the confluence of Plumely Canyon	6	110	247	405	608	1,015	1,277
Geer Canyon	Upstream of the confluence of Plumely Canyon	3	67	144	231	341	570	697

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	1% Annual Chance Plus	0.2% Annual Chance
Lefthand Creek	At U.S. Highway 36	58	1,463	2,751	4,117	5,794	9,676	11,458
Lefthand Creek	Upstream of the confluence of Geer Canyon	51	1,509	2,732	4,009	5,569	9,801	10,694
Lefthand Creek	Downstream of the confluence of Spruce Gulch	51	1,340	2,493	3,678	5,151	9,066	9,975

Attachments included in this Bid Addendum No. 2 are as follows:

1. Sample Pre-Authorization for Work
2. Confidential and Sensitive Information Sharing Agreement
3. USGS – Post-fire debris-flow hazard assessments

ATTENTION BIDDERS:

The submittal date and time is amended and extended from April 8, 2021 at 2:00 p.m. to **April 12, 2021 at 10:00 a.m.**

Submittal Instructions:

Submittals are due at the email box only, listed below, for time and date recording on or before **10:00 a.m. Mountain Time on April 12, 2021.**

Please note that email responses are limited to a maximum of 50MB capacity. NO ZIP FILES OR LINKS TO EXTERNAL SITES WILL BE ACCEPTED. Electronic Submittals must be received in the email box listed below. Submittals sent to any other box will NOT be forwarded or accepted. This email box is only accessed on the due date of your questions or proposals. Please use the Delivery Receipt option to verify receipt of your email. It is the sole responsibility of the proposer to ensure their documents are received before the deadline specified above. Boulder County does not accept responsibility under any circumstance for delayed or failed email or mailed submittals.

Email purchasing@bouldercounty.org; identified as **RFP# 7221-21** in the subject line.

All proposals must be received and time and date recorded at the purchasing email by the above due date and time. Sole responsibility rests with the Offeror to see that their bid is received on time at the stated location(s). Any bid received after due date and time will be returned to the bidder. No exceptions will be made.

The Board of County Commissioners reserve the right to reject any and all bids, to waive any informalities or irregularities therein, and to accept the bid that, in the opinion of the Board, is in the best interest of the Board and of the County of Boulder, State of Colorado.



**RECEIPT OF LETTER
ACKNOWLEDGMENT**

April 5, 2021

Dear Vendor:

This is an acknowledgment of receipt of Addendum #2 for **RFP# 7221-21; Cal-Wood Fire Infrastructure Protection Design-Build Project**. In an effort to keep you informed, we would appreciate your acknowledgment of receipt of the preceding addendum. Please sign this acknowledgment and email it back to purchasing@bouldercounty.org as soon as possible. If you have any questions, or problems with transmittal, please call us at 303-441-3525. This is also an acknowledgement that the vendor understands that **due to COVID-19, BIDS will only be accepted electronically by emailing purchasing@bouldercounty.org.**

Thank you for your cooperation in this matter. This information is time and date sensitive; an immediate response is requested.

Sincerely,

Boulder County Purchasing

Signed by: _____ **Date:** _____

Name of Company _____



Parks and Open Space

5201 St. Vrain Road • Longmont, Colorado 80503
303.678.6200 • Fax: 303.678.6177 • www.bouldercounty.org

SAMPLE -- PRE-AUTHORIZATION FOR WORK

Addendum NO. 2 Attachment

DATE:

RE: RFP# 7221-21- Cal-Wood Fire Infrastructure Protection Design-Build Project

CONTRACTOR:

I. The Tasks listed in Section II below (the “Tasks”) are required for the Project identified above. The Parties desire to enter into this Pre-Authorization for Work (“Pre-Authorization”) to authorize performance of the Tasks by the above-named Contractor, prior to entering into a full contract for the Project. The Parties agree that execution of this Pre-Authorization is in the Parties’ best interests as it facilitates commencement of low-risk preliminary tasks prior to completion of the contracting process that will maximize the available time for Project completion.

In consideration of the mutual covenants contained herein, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

1. No Additional Costs: The Parties agree that Contractor’s performance of the Tasks authorized hereunder shall not be charged to Boulder County (“County”) as an additional expense separate from the original Bid submitted to and accepted by County.
2. Tasks to be Performed: Contractor will perform the Tasks (a) in a good and workmanlike manner, (b) at its own cost and expense, and (c) in accordance with recognized industry standards of care, skill and diligence for the type of work being performed.
 - a. Contractor understands this Pre-Authorization does not constitute a Notice to Proceed for the Project; A separate notice will be issued upon execution of the Contract. Accordingly, this Pre-Authorization only authorizes performance of the Tasks.
3. Term/Termination: This Pre-Authorization shall become effective upon the date of last signature included below. In the event of a conflict between the full contract and the terms of this Pre-Authorization, the terms of the full contract shall control. County may terminate this Pre-Authorization upon seven (7) days’ notice to Contractor. In the event of termination of this Pre-Authorization by County, Contractor shall not be entitled to any compensation for the work performed hereunder .

4. Full Contract: The Parties agree to work together in good faith to enter into a full contract for the Project that is substantially similar to the sample contract supplied by County in the BID packet. Unless earlier terminated by County, this Pre-Authorization shall be automatically incorporate into the Parties' full contract for the Project upon execution thereof. In the event that the Parties fail to enter into a full contract for the Project, Contractor shall not be entitled to any compensation for the work performed hereunder.
5. Indemnity: Contractor will be liable for any damages to persons or property caused by or arising out of the actions, obligations, or omissions of Contractor, its employees, agents, representatives or other persons acting under Contractor's direction or control in performing or failing to perform the Tasks under this Pre-Authorization. Contractor will indemnify and hold harmless County, its elected officials and appointed department heads, and its employees, agents and representatives (the "indemnified parties"), from any and all liability, claims, demands, actions, damages, losses, judgments, costs or expenses, including attorneys' fees, which may be made or brought or which may result against any of the indemnified parties as a result or on account of the actions or omissions of Contractor, its employees, agents or representatives, or other persons acting under Contractor's direction or control. This indemnification obligation will extend to claims based on Contractor's unauthorized use or disclosure of confidential information and intellectual property infringement. County will not be obligated to indemnify or defend Contractor under any circumstances. Contractor's obligations under this provision shall survive expiration or termination of this Pre-Authorization.
6. Independent Contractor: Contractor is an independent contractor for all purposes in performing the Tasks. None of Contractor, its agents, personnel or subcontractors are employees of the County for any purpose, including the Federal Insurance Contribution Act, the Social Security Act, the Federal Unemployment Tax Act, the provisions of the Internal Revenue Code, the Colorado Workers' Compensation Act, the Colorado Unemployment Insurance Act, and the Public Employees Retirement Association. Accordingly, County will not withhold or pay any income tax, payroll tax, or retirement contribution of any kind on behalf of Contractor or Contractor's employees. As an independent contractor, Contractor is responsible for employing and directing such personnel and agents as it requires to perform the Tasks. Contractor will exercise complete authority over its personnel and agents and will be fully responsible for their actions.
7. Governing Law/Venue/Severability/No Third-Party Beneficiaries: The laws of the State of Colorado govern the construction, interpretation, performance, and enforcement of this Pre-Authorization. Any claim relating to this Contract or breach thereof may only be brought exclusively in the Courts of the 20th Judicial District of the State of Colorado and the applicable Colorado Appellate Courts. If any provision of this Pre-Authorization becomes inoperable for any reason but the fundamental terms and conditions continue to be legal and enforceable, then the remainder of the Pre-Authorization will continue to be operative and binding on the Parties.

Enforcement of the terms and conditions and all rights and obligations of this Pre-Authorization are reserved to the Parties. Any other person receiving services or benefits under this Pre-Authorization is an incidental beneficiary only and has no rights under this Pre-Authorization.

8. Governmental Immunity: Nothing in this Contract shall be construed in any way to be a waiver of the County's immunity protection under the Colorado Governmental Immunity Act, C.R.S. § 24-10-101, et seq., as amended.
9. Legal Compliance: Contractor is solely responsible for ensuring that its performance under this Pre-Authorization and the Tasks themselves will comply with all Federal, State, and local laws, regulations, ordinances and codes. County approval of the Tasks or any aspect of Contractor's performance, such as plans, designs, or other Contractor-drafted documents, shall not be interpreted to mean that Contractor has satisfied its obligations under this Section.
10. Ownership of Work Product: All work product, property, data, documentation, information or materials conceived, discovered, developed or created by Contractor pursuant to this Pre-Authorization ("Work Product") will be owned exclusively by County. To the extent possible, any Work Product will be deemed to be a work made for hire. Contractor unconditionally and irrevocably transfers and assigns to the County all right, title and interest in and to any Work Product.
11. Execution by Counterparts/Electronic Signatures/Authority to Sign: This Pre-Authorization may be executed in multiple counterparts, each of which will be deemed an original, but all of which will constitute one agreement. The Parties approve the use of electronic signatures, governed by the Uniform Electronic Transactions Act, C.R.S. §§ 24 71.3 101 to 121. The Parties will not deny the legal effect or enforceability of this Pre-Authorization solely because it is in electronic form or because an electronic record was used in its creation. The Parties will not object to the admissibility of this Pre-Authorization in the form of electronic record, or paper copy of an electronic document, or paper copy of a document bearing an electronic signature, because it is not in its original form or is not an original. By signing this Pre-Authorization, the person signing acknowledges that they have the authority to sign on behalf of Contractor.
12. Limitation of Liability: COUNTY SHALL NOT BE LIABLE TO CONTRACTOR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, PUNITIVE, OR INDIRECT DAMAGES ARISING FROM OR RELATING TO THIS PRE-AUTHORIZATION, REGARDLESS OF ANY NOTICE OF THE POSSIBILITY OF SUCH DAMAGES. COUNTY'S AGGREGATE LIABILITY, IF ANY, ARISING FROM OR RELATED TO THIS PRE-AUTHORIZATION, WHETHER IN CONTRACT, OR IN TORT, OR OTHERWISE, IS LIMITED TO, AND SHALL NOT EXCEED, THE AMOUNTS PAID OR PAYABLE HEREUNDER BY COUNTY TO CONTRACTOR.
13. Insurance: The attached Risk Management Insurance Requirements are hereby incorporated into this Pre-Authorization for Work. Contractor must submit to

County proof of its liability insurance, as required by the Risk Management Insurance Requirements, prior to commencing performance of any of the Tasks authorized by this Form.

II. **Tasks**

- 1. Background Information, Site Survey and Measurements, Risk and Cost/Benefit Analysis, and Recommendations
- 2. Engineering Services including plan preparation and applying for permits
- 3. Stamped Construction Plans and Specifications and Obtain Federal, State, and Local Permits

Acceptance by Name of Contractor:

By: Printed Name Date
Title: Printed Title

Acceptance by Boulder County:

By: Date
Title:

Please note this Pre-Authorization for Work will not be signed by the County until the selected contractor provides all required insurance documentation.

BOULDER COUNTY, COLORADO
CONFIDENTIAL AND SENSITIVE INFORMATION SHARING AGREEMENT

This Confidential and Sensitive Information Sharing Agreement (“Agreement”) is entered into by and between the Board of County Commissioners on behalf of the County of Boulder, State of Colorado, a body corporate and politic, for the benefit of the Parks and Open Space Department (“County”), and _____ (the “Recipient”). County and Recipient are each a “Party,” and collectively the “Parties.”

RECITALS

1. The Recipient has requested the disclosure of certain data gathered and held by the County that the County believes to be confidential and/or sensitive and immune from the disclosure requirements of the Colorado Open Records Act (CRS § 24-72-201 *et seq.*) (the “Protected Information”).
2. The County has determined that the Protected Information is exempt from disclosure to third parties because disclosure to third parties without the County’s permission would do substantial injury to the public interest under the Colorado Open Records Act (CRS § 24-72-203(1), CRS § 24-72-204(6)(a)).
3. Additionally, use and disclosure of the Protected Information is further governed by the County’s Sensitive GIS Data Policy adopted March 26, 2015, which is available upon request.
4. The County agrees that there are legitimate purposes to which the Recipient may use the Protected Information which do not violate the Colorado Open Records Act.
5. The Parties are entering into this Agreement to set forth the terms and conditions upon which the Protected Information will be disclosed to the Recipient and the limitations upon Recipient’s use of the Protected Information.

AGREEMENT

Now therefore, in consideration of the mutual covenants, conditions, and promises contained herein, and for other good and valuable consideration, the Parties agree as follows:

1. Recipient, in accepting the Protected Information, hereby acknowledges the limitations of such Protected Information and the restrictions on its use. The Protected Information being provided is intended to comply with the Recipient’s ability to use the Protected Information for its internal purposes, but while also acknowledging that the County has legitimate concerns about the Protected Information’s use by third parties.
2. No part of the Protected Information may be copied, reproduced, published in raw form or transmitted in any form or by any means whatsoever, including, but not limited to, electronic, mechanical, photocopying, recording, scanning, or by any information retrieval system that can be accessed by third parties without the County’s prior written consent. The Recipient shall not license, relicense, sub-license, assign, release, publish, transfer, sell or otherwise make available

any portion of the Protected Information to a third party without the prior express written permission of County.

3. If a third party makes a request for access to the Protected Information and alleges that it is entitled to disclosure of the Protected Information under the Colorado Open Records Act, if the Recipient is a governmental entity, it shall assert to the third party that the Protected Information is protected from disclosure by CRS § 24-72-204(6)(a) because its disclosure would do substantial injury to the public interest. If the third party challenges whether the Protected Information is protected from disclosure by CRS § 24-72-204(6)(a), the Recipient shall timely offer the County the opportunity to petition to a district court for an order permitting restriction from disclosure. If Recipient is not a governmental entity, Recipient shall instruct such third party to direct any Open Records Act requests to the County.

4. The Protected Information which is the subject of this Agreement has been developed solely for internal use only by County, and County makes no warranties, representations or guarantees, either expressed or implied, as to the completeness, accuracy or correctness of the Protected Information, nor accepts or assumes any liability arising from or for any incorrect, incomplete or misleading Protected Information provided pursuant to this purchase/request. There are no warranties and/or representations, either expressed or implied, of merchantability or fitness of the Protected Information for a particular purpose or use. The Recipient shall immediately notify the County in writing of any and all defects, errors, inaccuracies, or any other problems with the Protected Information discovered by Recipient.

5. The County is not responsible for incidental, consequential, or special damages arising from the use of the Protected Information provided to Recipient. Recipient agrees that the Protected Information shall be used and relied upon only at the risk of Recipient. Recipient agrees to indemnify and hold harmless County, its officials (elected or appointed), officers, employees, servants and agents from any and all liability, claims, losses, damages, injuries, costs and attorney fees arising out of procuring, compiling, collecting, interpreting, producing or communicating the Protected Information which is the subject of this Agreement.

6. Protected Information will remain the property of the County. The Recipient agrees that the Protected Information will be disclosed or disseminated only to the Recipient's employees who have a need to know and who are under an obligation limiting the use and disclosure of the Protected Information. Upon termination of this Agreement, or once the purpose for which Recipient received the Protected Information no longer exists, no further disclosure or dissemination of the Protected Information shall be permitted, except with written permission of the County. Recipient shall, to the extent practicable, destroy all Protected Information and shall provide the County with written confirmation once the Protected Information is destroyed.

7. Notice: Within sixty (60) days after a change of a Party's address, the Party shall provide the other Party with written notice of any change of address. For purposes of the notices required to be provided, all such notices shall be in writing, and shall be either sent by Certified U.S. Mail - Return Receipt Requested, Electronic Mail, or hand-delivered to the following representatives of the Parties at the following addresses:

To the County: Boulder County Parks and Open Space
Attention
5201 St. Vrain Road
Longmont, CO 80503

To the Recipient:

8. Pursuant to the terms of this Agreement, County shall provide Recipient the following Protected Information:

9. Additional conditions of and/or rights relating to the release to Recipient of the Protected Information are as follows:

10. General Provisions:

(a) Recipient warrants and represents to County that it has full power, right, and authority to enter into this Agreement and, where applicable, to act as agent for and to be bound to perform all the terms and conditions pursuant to, this request for Protected Information.

(b) Each Party, upon thirty (30) days prior written notice, may terminate this Agreement. The obligation to protect the confidentiality of information received prior to termination shall survive.

(c) This Agreement will be governed by the laws of the State of Colorado, excepting its conflicts of law provisions. This Agreement and any amendment thereto, must be in writing and signed by an authorized representative of each Party. No failure or delay in exercising any right under this Agreement will operate as a waiver of any term or condition hereunder.

(d) The Recipient agrees to use the same degree of care to protect the confidentiality of the information it receives from the County as it would use to protect its own confidential or sensitive information.

(e) This Agreement embodies the entire agreement between the Parties. The Parties shall not be bound by or liable for any statement, representation, promise, inducement, or understanding of any kind or nature not contained herein. No amendments, changes, modifications of any of the terms and conditions of this Agreement shall be valid unless reduced to writing and signed by the Parties. This Agreement is not assignable under any circumstances whatsoever. All of the terms and conditions of this Agreement shall remain in full force and effect and apply to any changes, updates, revisions or amendments to the Protected Information which is the subject of this Agreement.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement as of the last date set forth below.

RECIPIENT:

By: _____

Title: _____

Date: _____

THE COUNTY OF BOULDER, a body corporate and politic

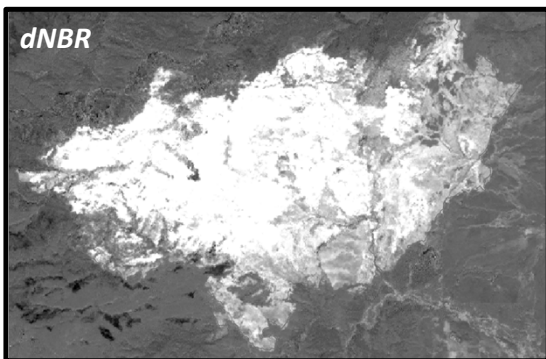
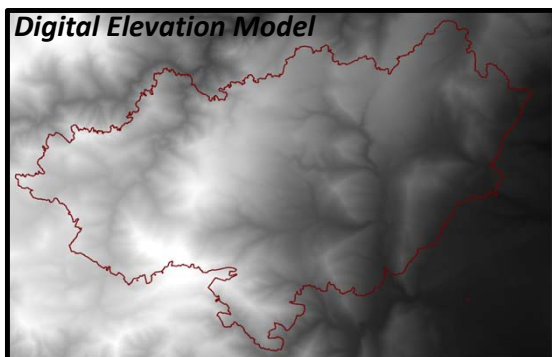
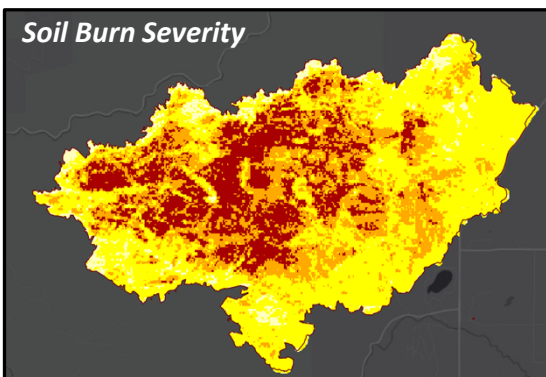
By: _____

Eric M. Lane, Director
Boulder County Parks and Open Space Department

Date: _____

SAMPLE

USGS – Post-fire debris-flow hazard assessments



INPUTS:

- *Soil burn severity (SBS)**
 - 46% of the Calwood area is burned at high and moderate severity
- *Steep slopes (>23 degrees; DEM)*
- *Soil erodibility*
- *Change in vegetation cover (dNBR)**
- *Rainfall intensity*

RESULTS:

- *Debris flow likelihood*
- *Potential Magnitude*
- *Combined Hazard*

*Provided by assessment requestor (BAER Team)

Likelihood Model

Inputs: basin **topography (DEM)**, **severity of fire (Soil Burn Severity)**, change in **vegetation cover (dNBR)**, **soil properties (KFFACT)**, and **rainfall intensity**.

Scientific background

DEM – 10-meter digital elevation model

Soil burn severity – field validated

dNBR – difference normalized burn index (satellite imagery)

KFFACT – Soil erodibility (SSURGO)

$$(1) P = e^x / (1 + e^x) - \text{Probability}$$

e^x is the exponential function where e represents the mathematical constant 2.718.

$$(1) (2) x = -3.63 + (0.41 \times X1R) + (0.67 \times X2R) + (0.7 \times X3R)$$

X1R - proportion of upslope area classified as high or moderate soil burn severity and with gradients $\geq 23^\circ$, multiplied by the peak 15-minute rainfall accumulation of the design storm (in millimeters [mm])

X2R - average (dNBR) of the upslope area, multiplied by the peak 15-minute rainfall accumulation of the design storm (in millimeters [mm]),

X3R - soil KF-Factor (Schwartz and Alexander, 1995) of the upslope area, multiplied by the peak 15-minute rainfall accumulation of the design storm (in millimeters [mm]).

Volume Model

Inputs: basin *topography (DEM)*, *severity of fire (SBS)*, and *rainfall intensity*.

Scientific background

DEM – 10-meter digital elevation model
Soil burn severity – field validated

Volume estimates are classified in order of magnitude scale ranges 0–1,000 m³; 1,000–10,000 m³; 10,000–100,000 m³; and greater than 100,000 m³ for cartographic display.

$$(3) \ln(V) = 4.22 + (0.13 \times \text{sqrt}(\text{ElevRange})) + (0.36 \times \ln(\text{HM}_{\text{km}})) + (0.39 \times \text{sqrt}(i15))$$

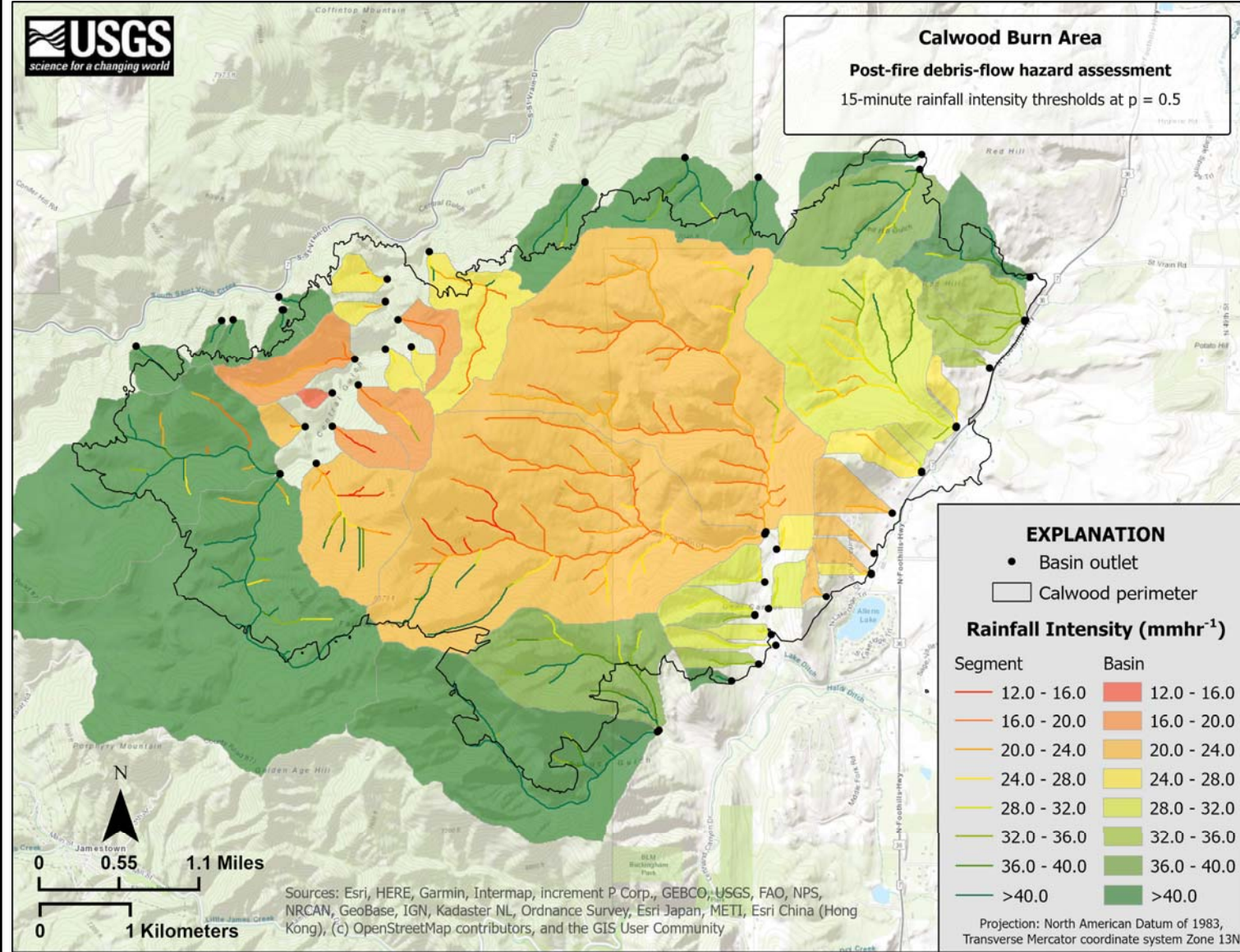
ElevRange - range (maximum elevation–minimum elevation) of elevation values within the upstream watershed (in meters)

HM_{km} - area upstream of the calculation point that was burned at high or moderate severity (in km²)

i15 - the spatially-averaged peak 15-min rainfall intensity for the design storm in the upstream watershed (in mm/h)



Calwood Burn Area
 Post-fire debris-flow hazard assessment
 15-minute rainfall intensity thresholds at $p = 0.5$



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

EXPLANATION

- Basin outlet
- Calwood perimeter

Rainfall Intensity (mmhr^{-1})

Segment	Basin
12.0 - 16.0	12.0 - 16.0
16.0 - 20.0	16.0 - 20.0
20.0 - 24.0	20.0 - 24.0
24.0 - 28.0	24.0 - 28.0
28.0 - 32.0	28.0 - 32.0
32.0 - 36.0	32.0 - 36.0
36.0 - 40.0	36.0 - 40.0
>40.0	>40.0

Projection: North American Datum of 1983, Transverse Mercator coordinate system Zone 13N

Rainfall thresholds are determined by basin **topography**, **severity of fire**, change in **vegetation cover**, **soil properties**, and **rainfall intensity**.

Fire-wide Rainfall Thresholds:
 15-minute: 30 mmhr^{-1} (0.3 inches in 15')
 30-minute: 23.5 mmhr^{-1} (0.5 inches in 30')
 60-minute: 22 mmhr^{-1} (0.9 inches in 60')

PDS-based precipitation frequency estimates with 90% confidence

Duration	Average recurrence interval (yr)					
	1	2	5	10	25	50
5-min	63 (51-79)	78 (63-97)	106 (85-133)	134 (107-168)	177 (139-239)	216 (163-295)
10-min	46 (37-57)	57 (46-71)	78 (62-97)	98 (78-123)	130 (102-175)	158 (119-214)
15-min	38 (30-47)	46 (37-58)	63 (51-79)	79 (64-100)	106 (83-142)	129 (97-174)
30-min	25 (20-31)	31 (25-39)	42 (34-53)	53 (43-67)	71 (55-95)	86 (65-117)
60-min	16 (13-20)	19 (15-24)	26 (21-33)	33 (26-41)	43 (34-58)	53 (40-72)