

SOLUTIONS



RESEARCH PROGRAMS Winter 2013

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PROJECT HIGHLIGHTS

Performance of Steel Pipe Pile-to-Concrete Cap Connections Subject to Seismic or High Transverse Loading: Phase III - Confirmation of Connection

Performance

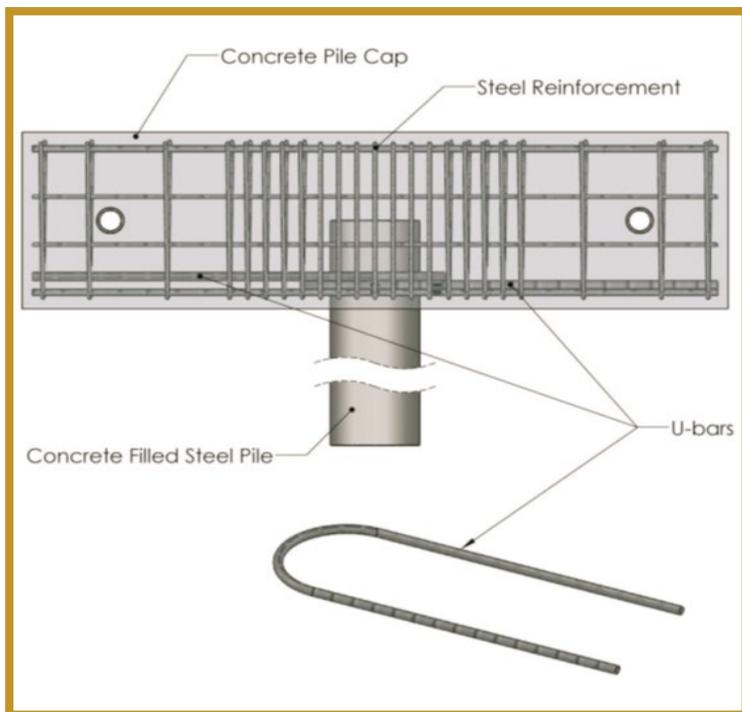
<http://www.mdt.mt.gov/research/projects/structures/seismic.shtml>

The Montana Department of Transportation (MDT) has found concrete-filled steel tube (CFT) piles connected at the top by a concrete pile cap to be a very cost effective support system for short and medium span bridges. This type of system offers low initial cost, short construction time, low maintenance requirements, and a long service life. From a structural engineering perspective, these systems must provide acceptable performance under gravity (i.e., self-weight and vehicle loads) and lateral loads (i.e., extreme ice, wind, and seismic events). While the gravity load performance of these systems is well understood, their strength and ductility under extreme lateral loads is more difficult to reliably predict using conventional design procedures. Therefore, MDT sponsored three phased research projects, conducted at the Western Transportation Institute (WTI), Montana State University (MSU), to investigate the performance of these systems under extreme lateral loads.

Four key limit states were observed in the accumulative testing: (1) formation of a plastic hinge in the CFT, (2) interior and exterior crushing of the cap concrete adjacent to the embedded pile, (3) yielding of the longitudinal reinforcement in the cap, and (4) splitting of the concrete cap. Based on the results of this investigation, the following recommendations were made regarding the efficacy of the MDT design methodology at addressing these limit states. Implementation activities are also included.

1. One possible improvement to predicting the plastic-moment capacity of CFTs might be to adopt the American Institute of Steel Construction (AISC) methodology for calculating the plastic-moment capacity of CFTs, as this methodology has been shown to be accurate at axial load ratios (i.e., ratio of applied axial load to ultimate axial capacity) common in bridge applications.

AASHTO incorporated the AISC methodology for calculating the plastic moment capacity of CFTs into the new seismic



Typical Test Specimen

design specification. MDT plans to adopt the AASHTO specification.

2. The concrete crushing limit state could be addressed by reducing allowed concrete compressive strengths and/or including interior U-bars near the tip of the embedded pile, which were shown to delay the onset of this limit state.

MDT will reduce allowed concrete compressive strengths and include interior U-bars near the tip of the embedded pile, as appropriate, to delay the onset of crushing in the interior of the cap.

3. To more comprehensively address yielding of the longitudinal reinforcement, it may be desirable to develop a mechanics model to better describe the effect of U-bars on this limit state, and reduce reliance upon empirical factors.

Recognizing the potential benefits of mechanics-based models relative to empirical relationships to describe physical behaviors, MDT and MSU either independently or collaboratively may further research and develop such models to better characterize longitudinal yield behavior of the U-bars.

4. Development of a more robust analytical model to predict cap splitting may be merited to reduce reliance on empirical factors and to generally improve design efficiency.

Similarly recognizing the advantages of developing a more robust analytical model to predict cap splitting, MDT and MSU either independently or collaboratively may further research and develop such a model.

5. To address possible unconservative branching of the design process based simply on level of moment demand on the connection as a fraction of CFT plastic moment capacity; this “branch” could simply be removed. If it were removed, the connection would always be designed based on the moment demand and would include additional reinforcement in the form of U-bars.

MDT will remove this “branch”.

For more information, contact Craig Abernathy at cabernathy@mt.gov or 406.444.6269.



Failure at Maximum Deflection on Return Pull



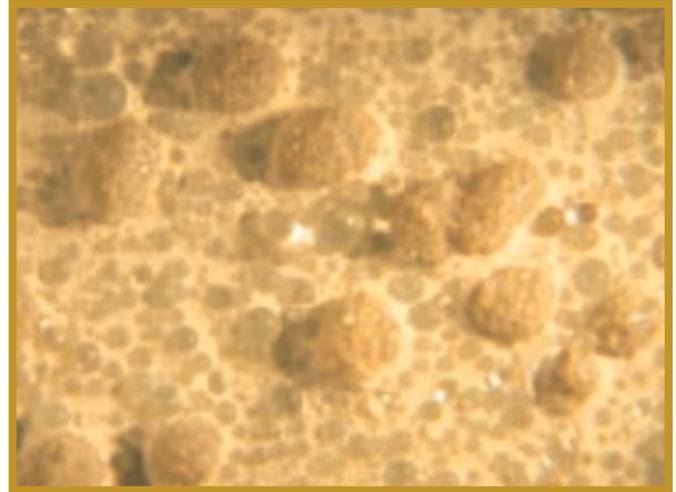
3M Wet Reflective Ceramic Elements™ and Visimax Plus Elements™: New Bead Technology for Added Retroreflectivity in Pavement Markings

Traditional pavement glass beads applied to highway pavement markings provide effective retroreflectivity in dry conditions. But add water, and their performance is severely limited. Water disrupts the glass bead visual system, preventing effective retroreflectivity. The net result: Drivers lose their most important guide in navigating roadways. Although this is always important, on rural roads, pavement markings may be motorists' only visual cue to keep them safely on the road.

In an effort to improve the visibility of pavement markings, especially during nighttime wet conditions, the Montana Department of Transportation (MDT) is initiating a trial to determine the effectiveness of two types of newly developed bead technology to be blended with conventional type 2 glass pavement beads.

The selected products are:

- ◇ 3M Elements Wet-Reflective Ceramic Beads™ and
- ◇ Visimax™ Glass Bead System, elements composed of a Visibead Core with a proprietary coating and bonded to thousands of highly reflective glass beads to form an outer shell.



Close-up of 3M Elements Wet-Reflective Ceramic Beads™

These new type of beads are claimed to provide increased retroreflectivity during wet conditions allowing states to apply the 20 mil (0.02 inches) thick pavement striping in a 60 mil (0.06 inches) channel, resulting in an increased durability during the plowing season. The retroreflectivity during wet conditions and durability will be evaluated to determine effectiveness as a future traffic and safety treatment.

For more information, contact Craig Abernathy at cabernathy@mt.gov or 406.444.6269.

Poly-Carb Mark High Friction Bridge Deck Treatment

The Department is nominating a project near Roundup, Montana over the Musselshell River as a preservation and performance enhancement treatment. This treatment includes, first, a solvent-less, low-viscosity polymer seal to repair (or chemically weld) cracks in concrete decks. Second, an epoxy and urethane layer with an application of glacial gravel (basalt quartzite granite) is placed as the friction course.

The chosen system is the Poly-Carb MARK – 135 SAFE-T-SEAL™ gravity fed crack repair system followed by application of the Poly-Carb MARK-163 FLEXOGRID Overlay System™. The aggregate source for the overlay



Overview of Poly-Carb Application



system will be Washington Rock Quarries Armor Stone. These materials were selected based on past successes, limiting variables (not mixed with squeegees), as well as other product attributes, which are anticipated to contribute to a more long-lasting application. Research staff will monitor the treatment for durability and skid resistance.

For more information, contact Craig Abernathy at cabernathy@mt.gov or 404.444.6269.



Poly-Carb Flexogrid Aggregate Treatment

SOLICITATION FOR RESEARCH PROJECT IDEAS

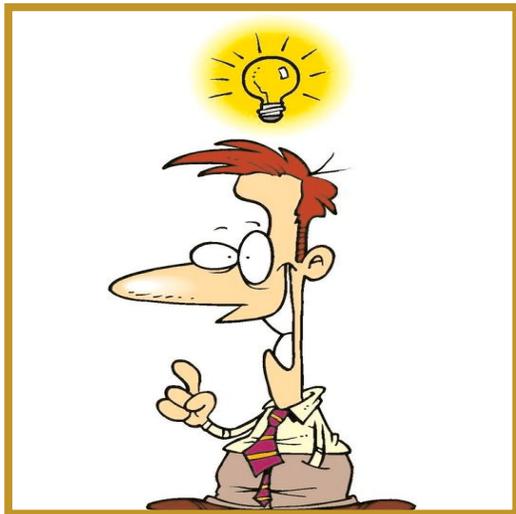
We need your ideas by April 30, 2013!

The Montana Department of Transportation (MDT) conducts research to discover, develop, or extend knowledge needed to operate, maintain, and improve the statewide multimodal transportation system. Specific goals include: evaluation and advancement

of new technologies, materials, and methods; development of design and analysis techniques; and study of current transportation challenges.

Every year, Research staff solicits for new research topics. Topics can be submitted by anyone at any time; however, they are due by April 30th of each year and may only be considered once a year during our annual solicitation. New projects are chosen by MDT's [Research Review Committee](#) in May of each year and proceed to technical panels, which determine if a research need exists and the most effective and efficient manner in which to conduct the research. Further information and solicitation problem statement forms can be found at <http://www.mdt.mt.gov/research/unique/solicit.shtml>. Information on various past and current research projects can be found at http://www.mdt.mt.gov/research/projects/sub_listing.shtml.

For more information, contact Sue Sillick at ssillick@mt.gov or 406.444.7693.





LIBRARY CORNER

Transportation Research: Suggestions for Better Searching

Transportation research is not always easily available by conducting a Google search, and sifting through the results can be tedious and frustrating, nor will it necessarily get you what you need. Not all search engines index all materials or the same materials. Also, anyone can post information on a website, so there is no indication of quality. In addition, it's difficult to narrow a search enough so that you can find what you need without sifting through a ton of hits. In order to more quickly and efficiently find what you're looking for, it is important to know where to search and how to search effectively.

Where to Search

The following websites and databases can be good places to start a search:

[MDT Library Catalog](#): The MDT library catalog includes current reports on transportation topics that pertain to the interests of MDT. The library has over 20,000 titles; approximately 5,000 of these are electronic resources, which means that the information is immediately available from the catalog record. All TRB publications are cataloged, most with both electronic and print access. FHWA reports, state DOT research reports, and even international publications and others are cataloged as well. One advantage of searching the library is that print publications (some of which are only available in print, not electronically – i.e. not found with a Google search) can be accessed fairly quickly.

[Transportation Research International Documentation \(TRID\) Database](#): This site, owned and maintained by the Transportation Research Board, now officially contains over 1,000,000 records of reports directly related to transportation topics. More than 90,000 of these records have links to full-text documents. TRID includes information from state DOTs, federal agencies, international organizations, and others on all

modes of transportation. TRID also contains records from the TRB's [Research in Progress \(RiP\) database](#), so one can see not only what's been done in the past but also what current research is being done on a particular topic.



[National Transportation Library \(NTL\) Integrated Search](#): This site searches the USDOT Headquarters Catalog, Digital Repository of full text research reports, and records that point to external transportation website content. Website content is diverse and includes data sets, publications, and institutional information.

[USDOT Research Hub](#): This is a web-based, searchable database that contains information on projects, both active and completed after September 2008, from 10 different USDOT administrations including: Federal Aviation Administration, Federal Highway Administration, Federal Motor Carrier Safety Administration, Federal Railroad Administration, Federal Transit Administration, Maritime Administration, National Highway Traffic



Safety Administration, Office of the Secretary of Transportation, Pipeline and Hazardous Materials Safety Administration, and the Research and Innovative Technology Administration.



Science.gov: Science.gov provides a way to access federal scientific information and research from 17 different organizations in one place. Transportation-focused information is available through this website from federal organizations such as the Bureau of Transportation Statistics, Center for Transportation Analysis, Federal Motor Carrier Safety Administration, National Institutes of Standards and Technology, National Transportation Research Center, U.S. Department of Transportation, and others. This database is useful because it provides one location to find information, saving the user the time of having to visit each organization's website.

These websites are by no means the only places to find transportation-related information online, but they are good places to begin searching. Regardless of which database is used, the following are some suggestions

and tips to enable better searching and to help obtain more precise results.

How to improve your search

1. Be clear on what you're searching for and break it down into concept keywords. Search engines and databases can more easily identify the items you're looking for when you exclude extraneous and unrelated words. Sometimes it can be helpful to write down a search statement that identifies the information you need and then highlight or circle key terms that may be used in a search. When you've identified these terms, you might also identify synonyms for the key terms; this will give you more search options.
2. Check TRB's [Transportation Research Thesaurus \(TRT\)](#) to see if there are other synonymous keywords you can try searching. Sometimes changing the words you use to search or searching more than one word at the same time using "OR" as a connector can produce better results. The TRT is also arranged hierarchically to narrow or broaden your search. If your search is too narrow, sometimes you won't find any information. In this case, try broadening your search. If your search is too wide, you might obtain too many results. In this case, you can narrow your search.
3. Boolean search operators can be used to specify to the database/website how to search your terms. The most common of these operators include "AND", "OR", and "NOT". If you link terms using "AND", it will narrow your search; it tells the database to search for results that contain both terms in the records. Linking terms using "OR" will broaden your search; it allows either word to be present in the results. If you use "NOT", you're telling the database/search engine to search for results where only the first word is used, and the second word is not included. Using these operators is a way to better communicate to search engines and databases what you need.



4. Take advantage of advanced search options if you want to narrow your results. Sometimes simple keyword searches are much too broad and produce too many results. Advanced search options allow you to be more specific and can produce search results more in line with what you need. You can add additional keywords to clarify what you're looking for, and depending on what database you're searching, you can specify if you need a certain date range, full-text access, scholarly/peer-reviewed, and so on.
5. When entering your search, try truncating search terms so that the database will search all variations of the term, and its singular and plural forms. In this case, to truncate means to shorten a word down to its root word. For example, "adjust" is a root word for the words: "adjust", "adjusts", "adjusting", "adjustment", and "adjustments". To truncate the term in a search, you would use a truncation symbol at the end of the root word; the most common ones are an asterisk, question mark, and plus sign. If you're not sure which symbol to use, look at the database's "Help" section to see if it specifies which symbol works for that particular search tool. A search word truncated might look like this: "vehicle*". If you enter this in a search, the results will include the singular and plural forms of that word. Truncation allows you to make sure that you're getting all pertinent results and saves the time of having to search for all for variations of a search term.
6. Keep in mind that when using truncation symbols, you're not restricted to using them only at the end of words. You can substitute them for any letter or letters, which can be useful if you're looking for variations in spelling. For example, you could search "gr*y", which would bring back results for both "gray" (primarily used in the United States) and "grey" (mostly used outside the U.S.). Also, sometimes plural forms do not occur at the end of the word, but are shown in a change of spelling, such as "men" as the plural form for "man". To search for this and similar words, you would put the symbol in the middle, "m*n" to get results for both terms. Please note that substitution and

truncation symbols may be different within each particular tool.

7. If you find a resource that seems especially helpful or pertinent to your search, scan through the references list to see if there are any other titles that



may relate to your topic. You may be able to get more information from the original sources, and you can take advantage of the work already done by the author to find that information. If the document has a Technical Report Documentation Page (usually located in the first few pages), this page has a field for keywords that you could look at; this may give you suggestions for other keywords to try. Scanning through the document for keywords may also be helpful. Finally, the search results may provide additional key words in the indexed record to try in an additional search.

Hopefully these suggestions will help you to find the information you need more quickly and efficiently. If you need any assistance or would like a literature search performed for you on a specific topic, please contact the MDT library, 406.444.6338 or mdtlibrary@mt.gov.



DID YOU KNOW?

Transportation Research Board



The mission of the [Transportation Research Board \(TRB\)](#) is to promote innovation and progress in transportation through research. TRB is one of six major divisions of the National Research Council – a private, nonprofit institution that is the principal operating agency of the National Academies in providing services to the government, public, and scientific and engineering communities. A resource to the nation and transportation community worldwide, TRB provides an extensive portfolio of services: opportunities for information exchange on current transportation research and practice, management of cooperative research and other research programs, analyses of national transportation policy issues, guidance on federal and other research programs, publications, and access to research information from around the world.

TRB fosters information exchange through the [Annual Meeting](#) - where in 2013, 11,700 transportation professionals from around the world gathered to participate in the world's largest transportation research forum designed specifically for the formal and informal exchange of information among transportation researchers and practitioners. Also, each year, TRB organizes about 100 specialty [webinars, conferences and workshops](#) on subjects and issues of interest to the transportation community. Often, these events offer professional development hours (PDH). In addition, TRB maintains more than 200 [standing committees and task forces](#) that address all aspects and modes of transportation. Committee members identify research needs; provide information to the transportation community on research priorities and procedures; review papers for presentation at the Annual

Meeting and for publication; encourage the incorporation of appropriate research findings into practice; and develop special programs, conferences, and workshops. Finally, each year, TRB technical staff visits all state transportation departments, several academic and research institutions, and other transportation-related agencies and organizations to exchange information concerning research and practice.

TRB administers a number of applied [research programs](#):

- ◇ [Airport Cooperative Research Program \(ACRP\)](#) sponsored by the Federal Aviation Administration,
- ◇ [National Cooperative Highway Research Program \(NCHRP\)](#) sponsored by the State Departments of Transportation,
- ◇ [National Cooperative Rail Research Program \(NCRRP\)](#) sponsored by the Federal Rail Administration,
- ◇ [Transit Cooperative Research Program \(TCRP\)](#) sponsored by the Federal Transit Administration,
- ◇ Various [legal research programs](#) (highway, transit, and airport),
- ◇ Various [synthesis programs](#) (highway, transit, airport, rail, and commercial truck and bus safety), and
- ◇ Strategic Highway Research Programs (SHRP). The most recent of the SHRP programs is [SHRP 2](#), for which the research is being completed and [FHWA](#) and [AASHTO](#) are working together to manage implementation.

TRB also administers the various [Innovations Deserving Exploratory Analysis \(IDEA\)](#) programs (highway, transit, and airport) which encourage investigation of innovative, but untested concepts



**MONTANA DEPARTMENT OF TRANSPORTATION
RESEARCH PROGRAMS**

offering the potential for technological breakthroughs in transportation. In addition, TRB conducts [policy studies](#) at the request of Congress, executive-branch federal agencies, and other organizations on an array of complex and often controversial transportation topics of national significance.

Finally, TRB offers a variety of tools to assist transportation researchers and practitioners. Since MDT is a TRB Sponsor, MDT staff has free access to these services and tools

- ◊ [Annual Meeting Online](#): This portal contains papers, slides, posters, and other information from the 2011-2013 TRB Annual Meetings. MDT staff need to create a log-in for free access.
- ◊ [Library](#): The TRB Library is the primary archive for publications of TRB.
- ◊ [Online Directory](#): This tool provides access to points of contact and information on TRB’s standing committees and task forces, project-based committees and panels, and governing committees, as well as to lists of TRB sponsors, affiliates, and representatives. In addition, the directory provides password-controlled access to contact information for TRB’s more than 7,000 volunteers, which is available to MDT staff as a TRB sponsor, after creating a log-in.
- ◊ [Practice-Ready Papers Database](#): This database contains peer-reviewed papers that are ready to implement into practice to make a contribution to the solution of current or future problems or issues for practitioners.
- ◊ [Research Funding](#): TRB’s Funding Sources for Transportation Research: Competitive Programs is designed to help researchers identify potential

organizations where they may submit research statements to obtain funding.

- ◊ [Research Needs Statements \(RNS\) Database](#): This database contains RNS that address concerns, issues, or problems facing the transportation community and are vetted and entered by over 200 TRB standing committees and task forces.
- ◊ [Research in Progress \(RiP\) Database](#): RiP contains nearly 10,000 records of current or recently completed research projects from State Departments of Transportation, US DOT, University Transportation Centers, Canada, Europe, and others.
- ◊ [Transportation Research International Documentation \(TRID\) Database](#): TRID combines records from TRB’s Transportation Research Information Services (TRIS) Database and the Organisation for Economic Cooperation and Development (OECD) Joint Transportation Research Centre’s International Transport Research Documentation (ITRD) Database, and provides access to more than one million records of transportation research worldwide.
- ◊ [Transportation Research Thesaurus \(TRT\)](#): The TRT is a tool to improve the indexing and retrieval of transportation information by providing a common and consistent language between producers and users of transportation information.

Take advantage of these resources and opportunities to get involved!

For more information, contact Sue Sillick at ssillick@mt.gov or 406.444.7693.





CALENDAR OF EVENTS

March

ACRP Research Statements Due (3/15/13)
TCRP Synthesis Research Statements Due (3/15/13)
SHRP 2 Implementation Assistance Funding Request Due (3/22/13)
AASHTO SCOR Meeting and NCHRP Project Selection (3/26/13-3/27/13)
MDT RRC Meeting (3/27/13)

April

National Library Week (4/8/13-4/13/13)
MDT Research and Library Customer Appreciation Day (4/10/13)
MDT RRC Meeting (4/24/13)
MDT Research Topic Statements Due (4/30/13)

May

AASHTO Spring Meeting (5/3/13-5/7/13)
MDT RRC Meeting (5/29/13)

June

NCRRP Research Statements Due (6/15/13)
TCRP Research Statements Due (6/15/13)
MDT RRC Meeting (6/26/13)

July

AASHTO RAC Meeting (7/15/13-7/18/13)
MDT RRC Meeting (7/31/13)

August

TRB Annual Meeting Papers Due (8/1/13)
WASHTO Annual Meeting (8/4/13-8/8/13)
MDT RRC Meeting (8/28/13)



MDT RESEARCH AND LIBRARY CUSTOMER APPRECIATION DAY - APRIL 10TH

On April 10th, 10 AM - 2 PM, we will be hosting Customer Appreciation Day at MDT Headquarters,



Auditorium East, to showcase MDT’s research and experimental projects and the library services and resources that are available to our customers. This event will feature snacks, games, and door prizes. This event coincides with National Library Week; the theme this year is “Communities Matter @ Your Library”. We will have displays and posters to demonstrate how various communities and the concept of “community” impact the MDT Library and its users. Please feel free to stop by; we would love to talk to you more about the services we offer and to show how much we appreciate your ongoing support.

For more information, contact Katy Callon at kcallon@mt.gov or 406.444.6338.



NEW REPORTS

[Evaluation of High Density Polyethylene Pipe \(HDPE\) Culvert in a Mainline Application](#)

[Evaluation of TD5200 Boomerang and The Flexi-Guide FG300 Ur Reboundable Surface Mount Delineators for Centerline Two-way, Two-lane Traffic Control](#)

[Impacts to Montana State Highways Due to Bakken Oil Development](#)

[Performance of Steel Pipe Pile-to-Concrete Cap Connections Subject to Seismic or High Transverse Loading: Phase III](#)

A listing of all past and current projects can be found at www.mdt.mt.gov/research/projects/sub_listing.shtml.

NEW PROJECTS

[Assessing the Effectiveness of Montana's Occupant Protection Program](#)

[Information/Educational Campaign for Roundabouts](#)

[Transportation System Preservation AASHTO Technical Services Program](#)

A listing of all past and current projects can be found at www.mdt.mt.gov/research/projects/sub_listing.shtml

REMINDER

Information on research services and products, such as research and experimental project processes and reports and technology transfer services, can be found on the Research web site at www.mdt.mt.gov/research.

MDT's library collection can be searched through the library catalog. Visit the [library home page](#) for a link to the catalog.

CONTACT US

Sue Sillick – Research Programs Manager
406.444.7693
ssillick@mt.gov

Kris Christensen - Research Projects Manager
406.444.6125
krchristensen@mt.gov

Craig Abernathy – Experimental Projects Manager
406.444.6269
cabernathy@mt.gov

Katy Callon – Librarian
406.444.6338
kcallon@mt.gov