



**Remote Loading Project  
(6 Foot Phase - Pre and Post Cleaning Jumbo  
Drill Holes)**

**TesMan October 2014  
Work Package Report**

## TABLE OF CONTENTS

Milestones for October’s Work Packages .....	3
Report on October Work Package Results .....	4
Introduction to the Project .....	4
Format of the Technology Development .....	4
In the Hole Cleaning Tools .....	4
Figure 1: Image of Progressive Development of Drill Hole Auditing Package .....	5
Format of the Technology Development .....	5
The Bolt On Process for Standard Loader Basket .....	5
Figure 2: Coleman Mine MacLean Engineering Loading Boom and Basket .....	6
Figure 3: The Approximate Geometry of a Stand Off Remote Cleaning Mounting Point .....	7
Figure 4: The Approximate Dimensions of an Average Loading Boom and Basket Retracted ..	8
Figure 5: The Approximate Dimensions of an Average Loading Boom and Basket Extended ..	9
Figure 6: Set Up Positions of the Loader to Reach the Hole (18’ High x 32’ Wide Face) .....	10
Figure 7: Choices of Side or Centre Loading / Cleaning Equipment Options .....	11
Figure 8: Showing a Simple Set of Upper and Lower Rails to Support the Cleaning Equipment	12
Figure 9: The Possible Quick Attach Format of In Hole Cleaning Tools to Be Investigated .....	13
Figure 10: A Concept of the Arm Supporting and Steering the Cleaning Equipment .....	14
Reception of Loaders To Development Tools .....	14
Mapping Process of Jumbo Drill Holes .....	15
Figure 11: Ore Chunk Blocking Drill Hole at 11 Feet Depth .....	16
Figure 12: Typical Damage to Drill Hole Walls in Rock (Waste) .....	17
Index of Mapping Data and Video .....	17
Present Conceptual Loading Basket Bolt On Cleaning Solutions .....	17
Safety Review of Pre and Post Drill Hole Cleaning Regulations .....	17
Conceptual Cleaning Tools to Test .....	18
Figure 13: Down the Hole Cleaning Tool Concepts .....	18
Figure 14: Moving 5/8 Loading Hose Around Chunk Less Than 50% Hole Diameter .....	19
Equipment Supplier Progress To Date .....	20
Website Communication Tool .....	20
Database Analysis .....	20
Milestones for November’s Work Package .....	21
Milestones for Future Work Packages (In Development) .....	22
December Work Package .....	22
January Work Package .....	22
February Work Package .....	23
March Work Package .....	23

## Milestones for October's Work Packages

- OCTOBER WORKPACKAGE
- BRAINSTORM & DETAIL BOLT ON FOR DRAWING & UG TESTS REQUIRED
- UG COLEMAN GATHER LIBRARY DATA OF CLEANING CHALLENGES IN HOLES
- COMPLETE & DRAFT CONCEPTUAL SOLUTIONS AND OPTIONS FOR BOLT ON CLEANING
- SETUP EQUIPMENT SUPPLIER TECHNICAL COMMITTEES AND CONTRACTS
- COMPLETE SUPPLIER FAB QUOTES (BOLT ON FEED ARM DESIGN DEC)
- INITIATE SAFETY REVIEW LOADING AND CLEANING REGULATIONS
- SETUP WEBSITE COMMUNICATION TOOL

## **Report on October Work Package Results**

### **INTRODUCTION TO THE PROJECT:**

The project work at Coleman is public domain and all details, data, video, and drawings will be made available through the TesMan website from mid November onwards.

The objective of the project is to create a working practical system with the tools that allows a development miner, in particular the explosives loader, to be able to remotely clean the jumbo drilled holes, 2 inches in diameter and 15 feet long approximately, from a distance of at least 6 feet, before and after blasting.

These tools and processes, if combined with the available other products and equipment available, will allow the development miner to complete the entire development cycle without going within 6 feet of the face ever.

The final few months of this project require the entire cycle to be tested. All development work is being conducted underground at Coleman Mine with the development miners and loaders.

The project is presently supported by VALE Canada Ltd. and Sudbury Integrated Nickel Operations (Sudbury INO).

### **FORMAT OF THE TECHNOLOGY DEVELOPMENT:**

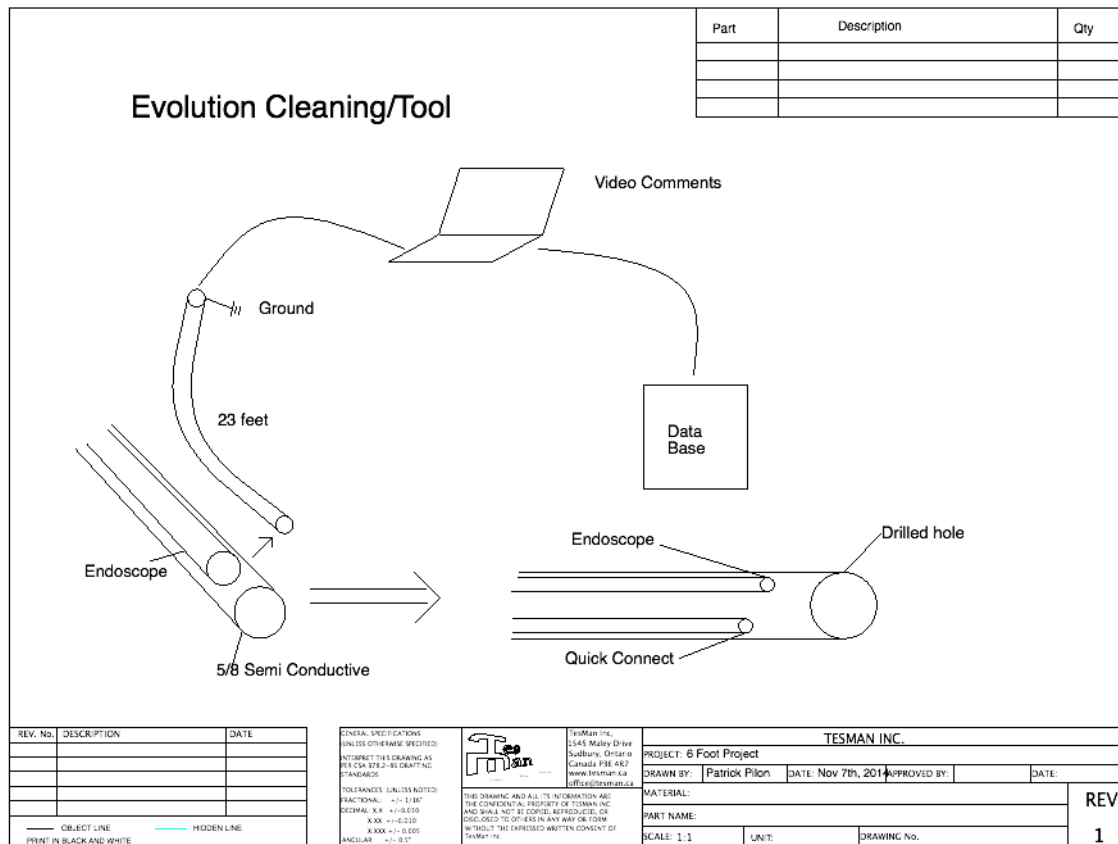
#### **IN THE HOLE CLEANING TOOLS:**

This entire 9 month project is an evolution of the final drill hole cleaning process. The present drill hole auditing tool is also testing a working format that can be utilized, if required, in the final cleaning process. It is already clear that any tool used to clean a jumbo drill hole cannot be robust enough to last for any significant length of time, it is a consumable element. Figure 1 shows how the auditing tool has developed so far to provide satisfactory results and survive the wear and tear inside the drill hole. The components used in the auditing tool include:

- Endoscope 10 m USB Cable / Wire Camera 4 LED
- Apple Mac Book (with keyboard cover)
- Camera Drivers and Video / Photo / Comment interface written by TesMan
- Tape Measures and Angle Indicators
- Photographs and Notebooks

Many of these components will change and be upgraded as the project continues.

A library is being compiled of all data and bore hole videos taken related to the development / tunnel rounds measured to date for analysis once data is complete.



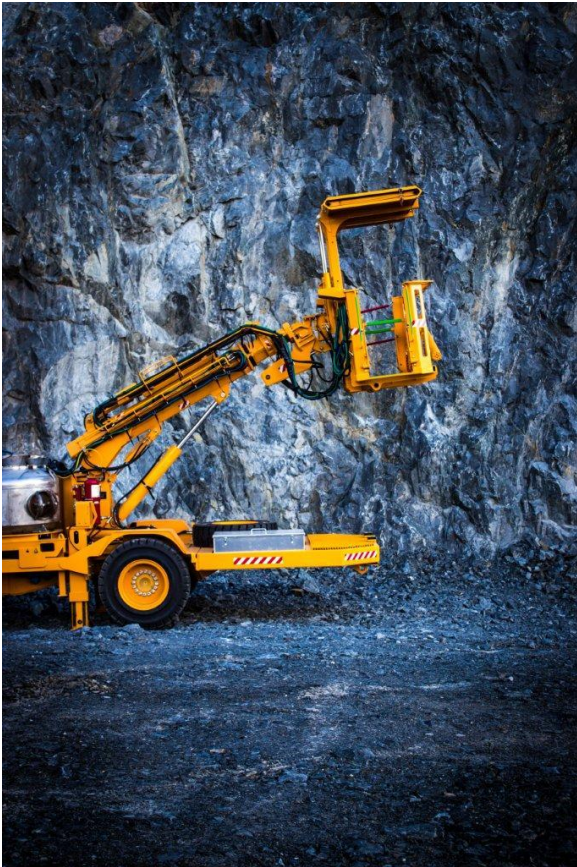
**Figure 1: Image of Progressive Development of Drill Hole Auditing Package.**

**FORMAT OF THE TECHNOLOGY DEVELOPMENT:**

**THE BOLT ON PROCESS FOR STANDARD LOADER BASKET:**

The prototype cycle keeping the miner 6 feet away from the face, will be conducted at Coleman Mine towards the end of the 9 months time frame, once the Remote Cleaning technologies have been perfected.

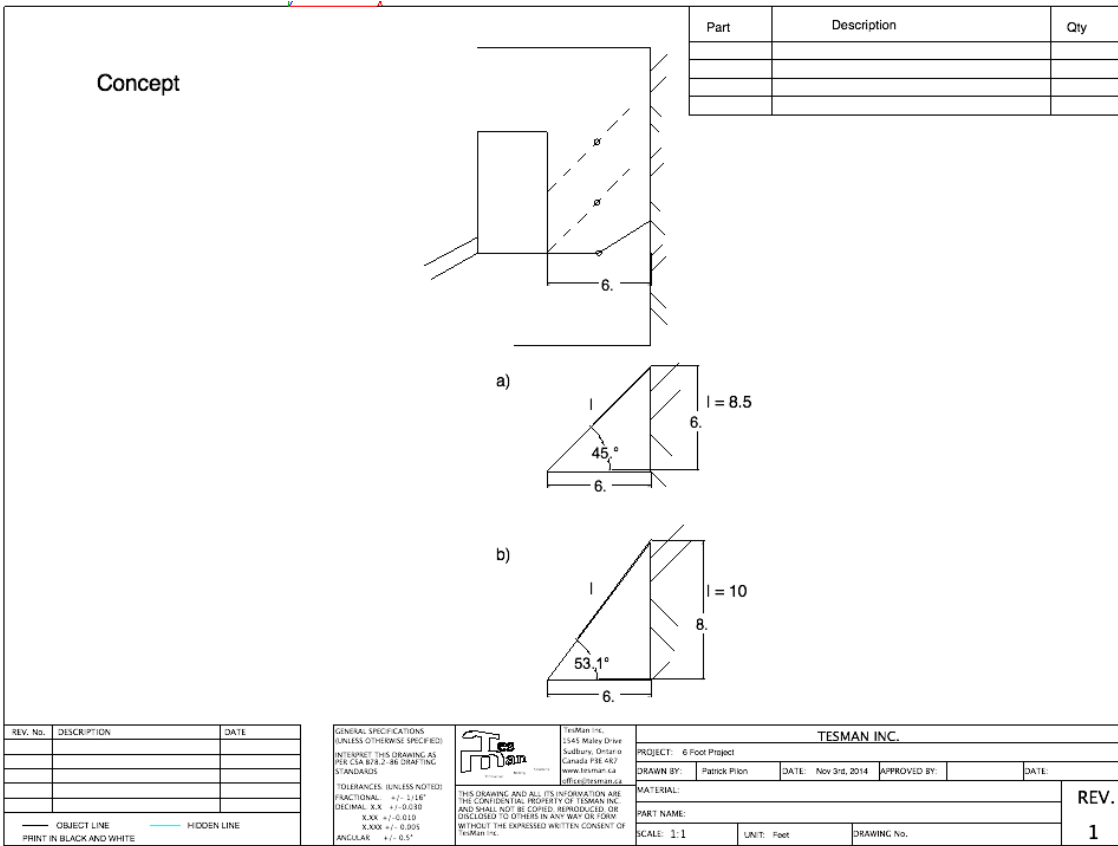
For this prototype cycle, the equipment available at the mine will be used, therefore the MacLean Engineering Loader with Boom and Manbasket Basket will probably be used, shown in Figure 2 .



**Figure 2: Coleman Mine MacLean Engineering Loading Boom and Basket**

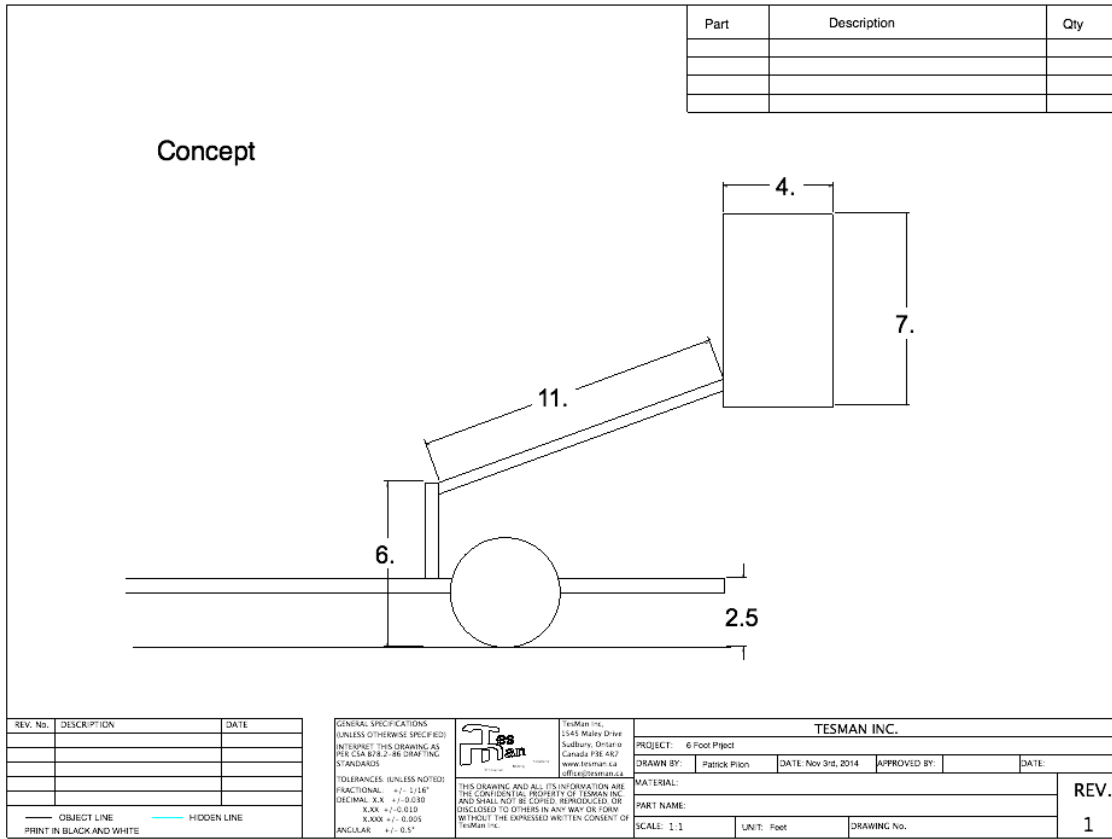
In preparation for bolting this cleaning technology onto the man basket

The first step was to conceptualise the geometry of the probable layout of the bolt on equipment, shown in Figure 3.



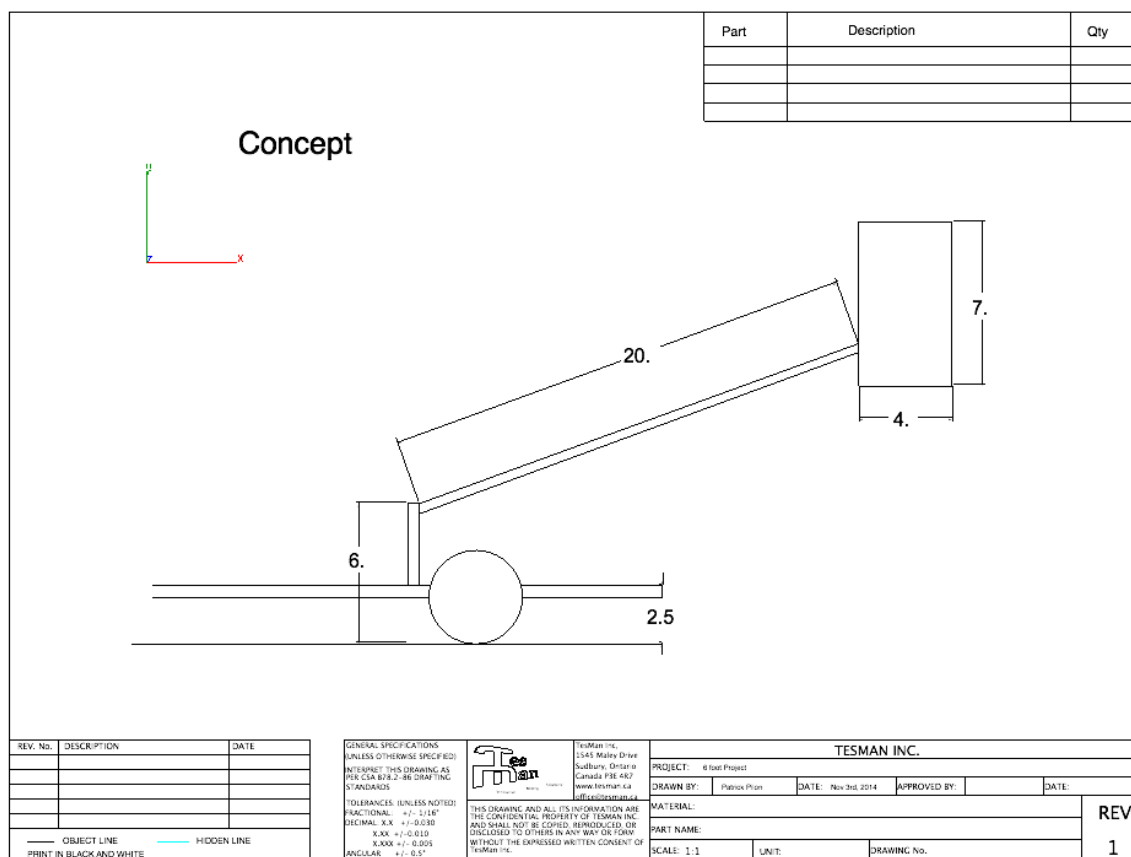
**Figure 3: The Approximate Geometry of a Stand Off Remote Cleaning Mounting Point**

The setup capability of the average boom and basket loading machine, ANFO or Emulsion is the second stage of Geometry review (Figures 4 & 5)



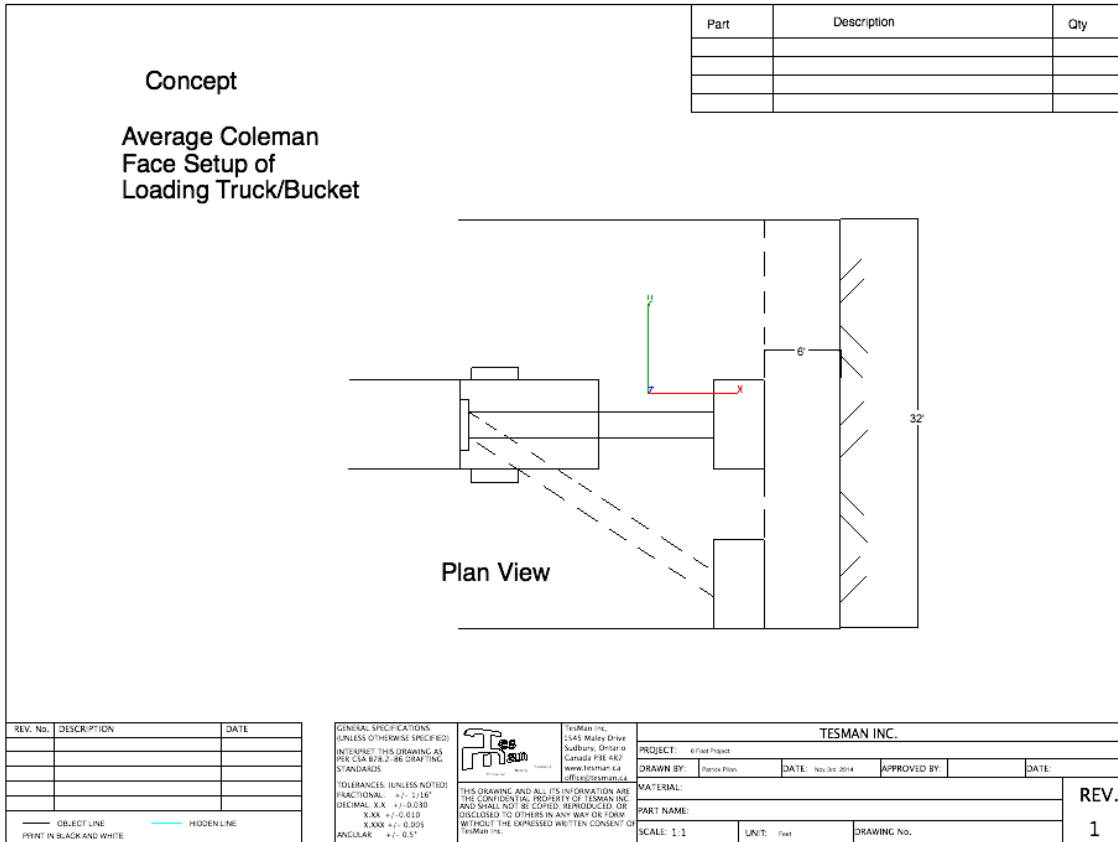
**Figure 4: The Approximate Dimensions of an Average Loading Boom and Basket Retracted**





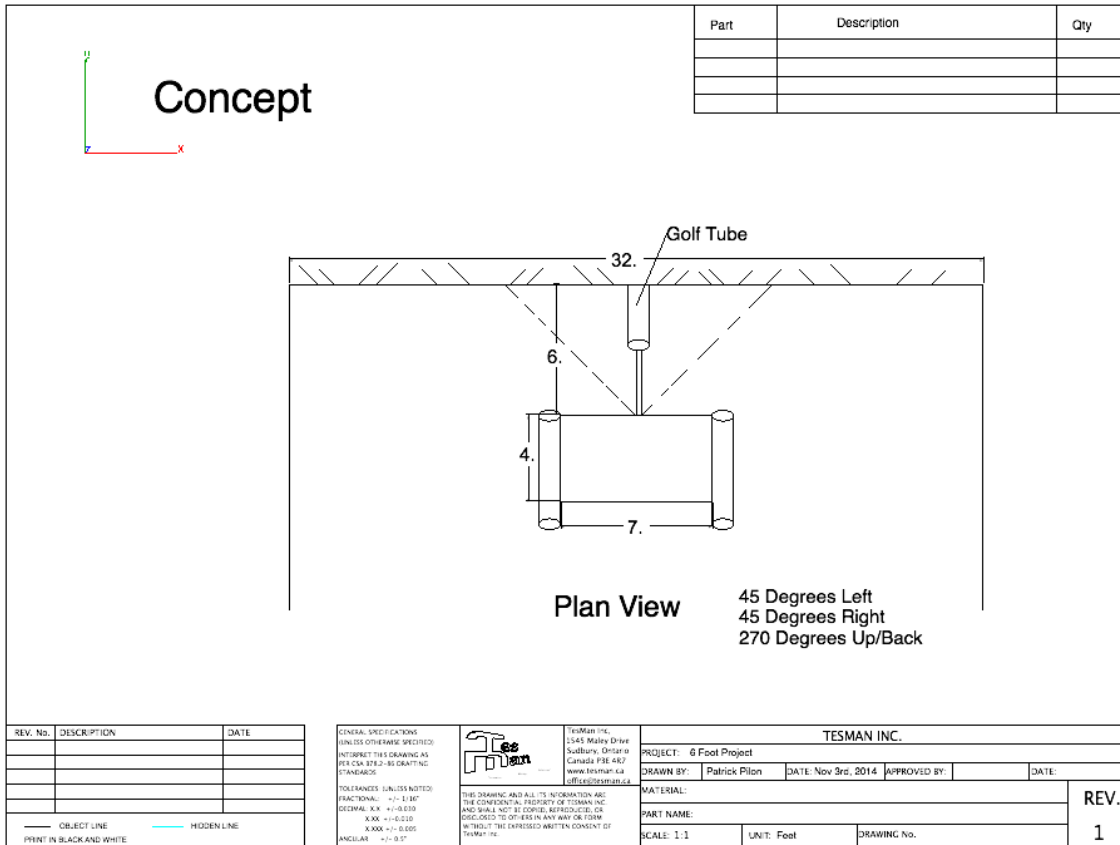
**Figure 5: The Approximate Dimensions of an Average Loading Boom and Basket Extended**

The third stage is reviewing the number of setup positions required, to ensure in the design of the bolt on apparatus, that for the convenience of the loader and efficiency of the loading process, as few loader setups and as few basket moves as possible are required. (Figure 6).



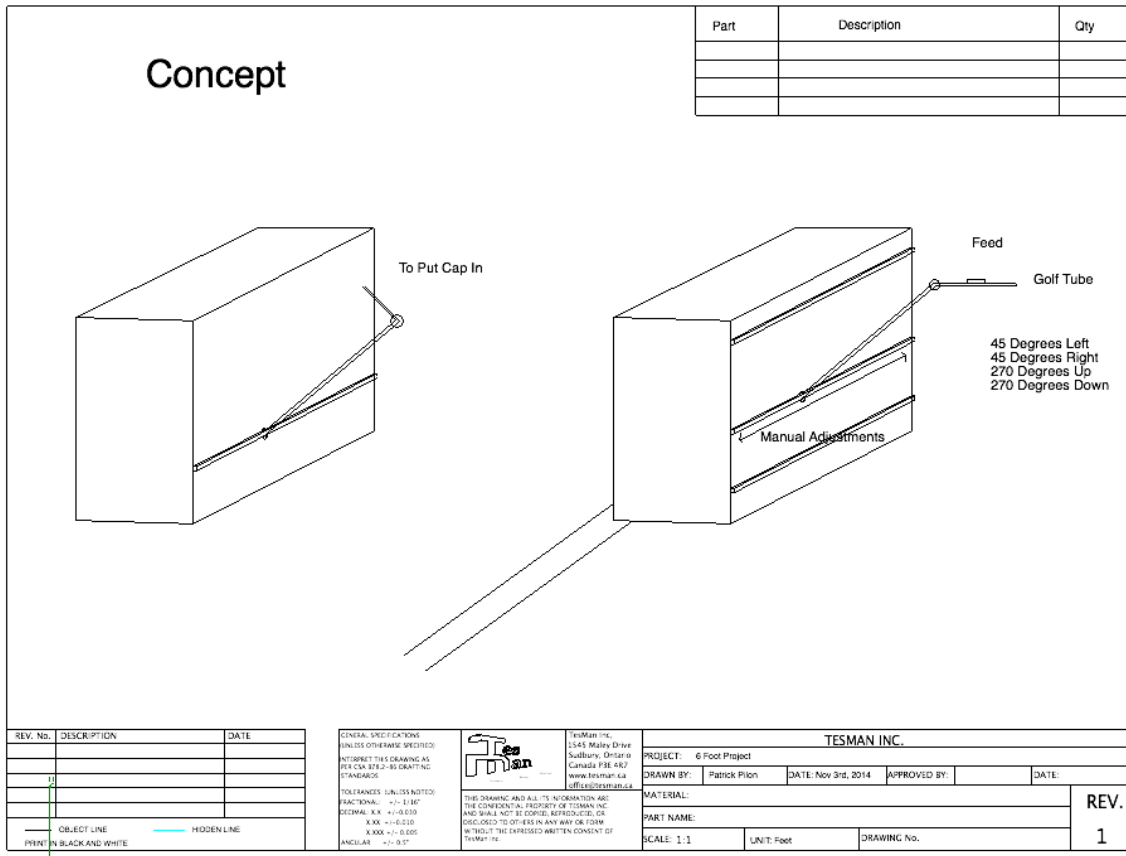
**Figure 6: Setup Positions of the Loader to Reach the Whole (18 ft High x 32 ft Wide Face)**

Next the choice has to be made between the mounting point and number of mounting points of the loading / cleaning equipment to the front of the basket (Figure 7). It seems more sensible between the choices to have a single set of loading tubes.



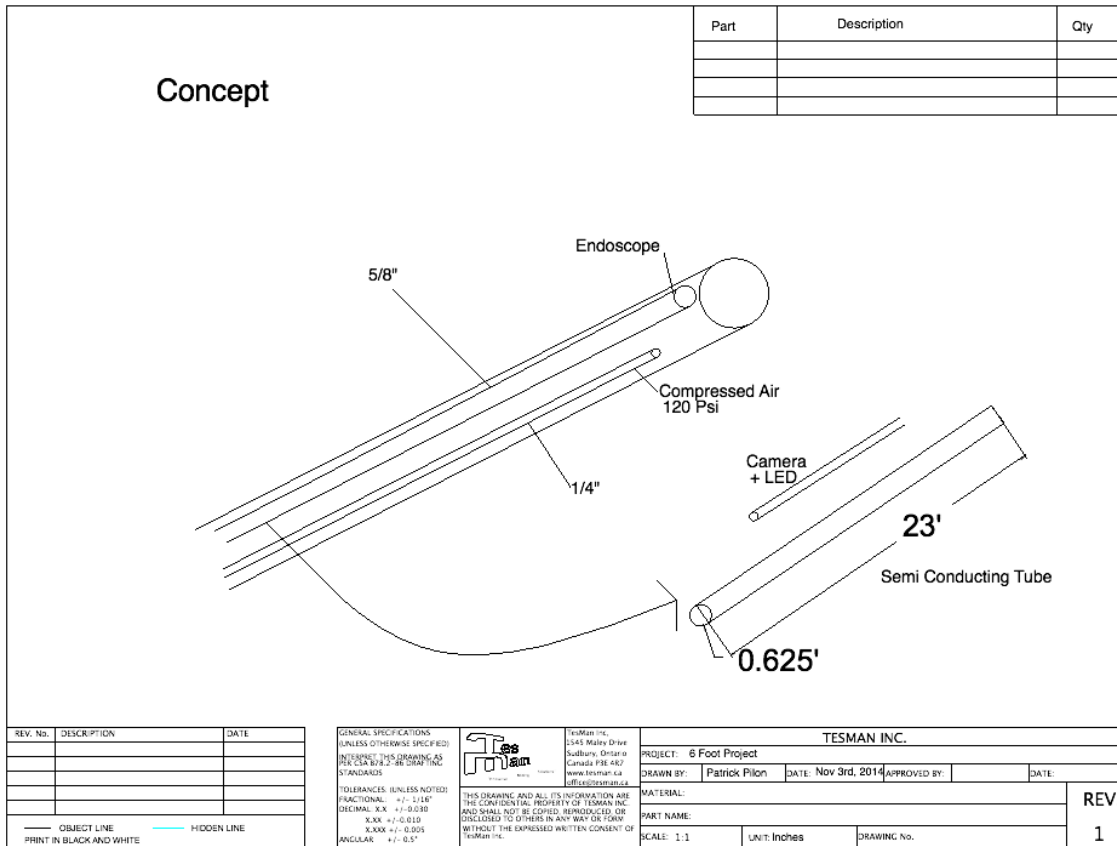
**Figure 7: Choices of Side or Center Loading / Cleaning Equipment Options**

In order to simplify the mechanics of the cleaning equipment, it is an option to have the centre facing mounting point able to be pushed from left side to right side of the basket, by mounting it on a set of free moving rails on the front of the basket (Figure 8)



**Figure 8: Showing a Simple Set of Upper and Lower Rails to Support the Cleaning Equipment**

The present auditing tool could be the basis, or one of the final choices of cleaning tool, in which case there has to be a mechanism to attach and change the in hole cleaning tools from the cleaning hose (Figure 9).

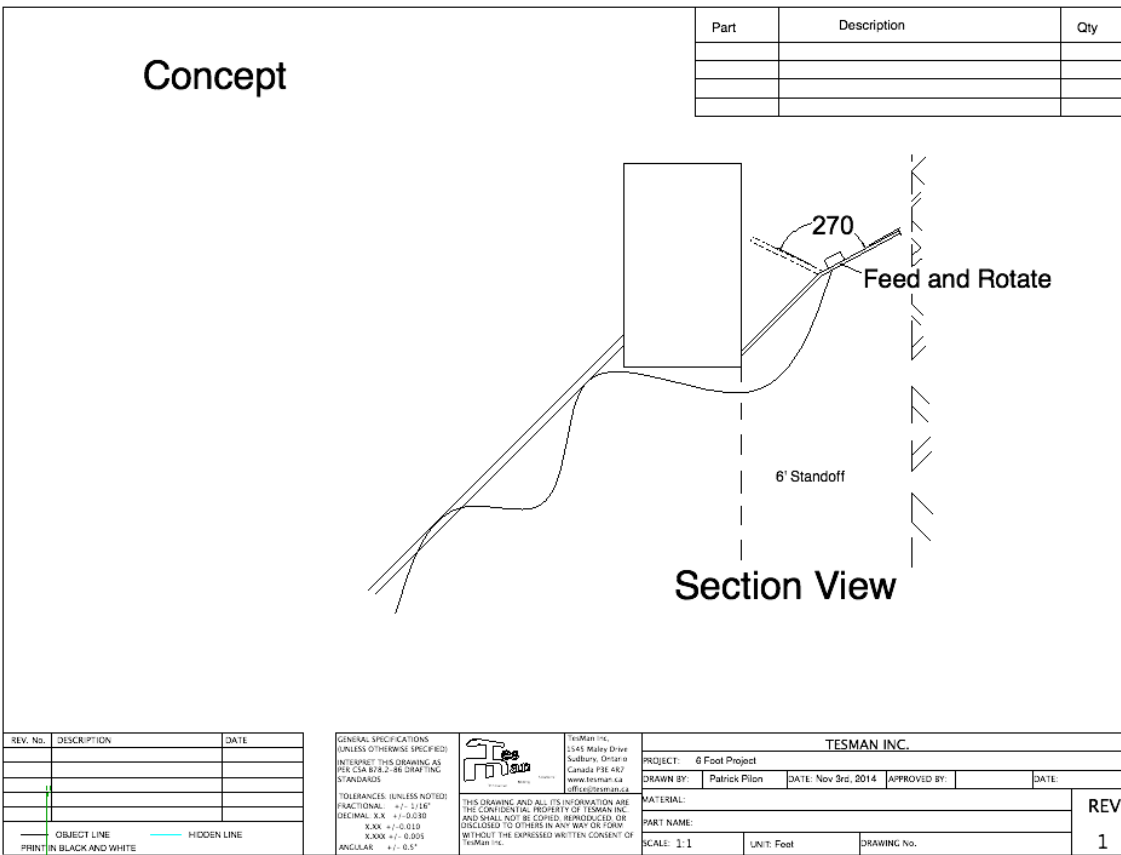


**Figure 9: The Possible Quick Attach Format of In Hole Cleaning Tools To Be Investigated**

Finally, through the review of all of the above options, and to avoid excessive 90 degree bends in the cleaning tube hose, the feed and retract tool on the final cleaning equipment needs to have two primary functions:

- It needs to bridge the minimum 6 foot gap to the face with the feed process away from the basket
- It needs to be able to fold the feed process back to the basket so that the loader can place the cap in the end of the hose manually

To achieve this a simple robust arm is required that can be operated from the basket (Figure 10)



**Figure 10: A Concept of the Arm Supporting and Steering the Cleaning Equipment**

**RECEPTION OF LOADERS TO DEVELOPMENT TOOLS:**

Taking non standard equipment underground requires significant input from those who work there daily, if the process is to survive the underground conditions. The fact that a working tool has been created has a lot to do with the support of the loaders, and the logistics of travelling to and from the faces on an almost daily basis is in thanks to the support of the staff and crew members as a whole.

Loaders are looking for the following:

- Be in a safe location
- Know the depth of the hole cleaned
- Be able to get the hose to the known bottom of the hole to load it
- Have tools to be able to remove or move or to move past any obstacles in the hole

**MAPPING PROCESS OF JUMBO DRILL HOLES:**

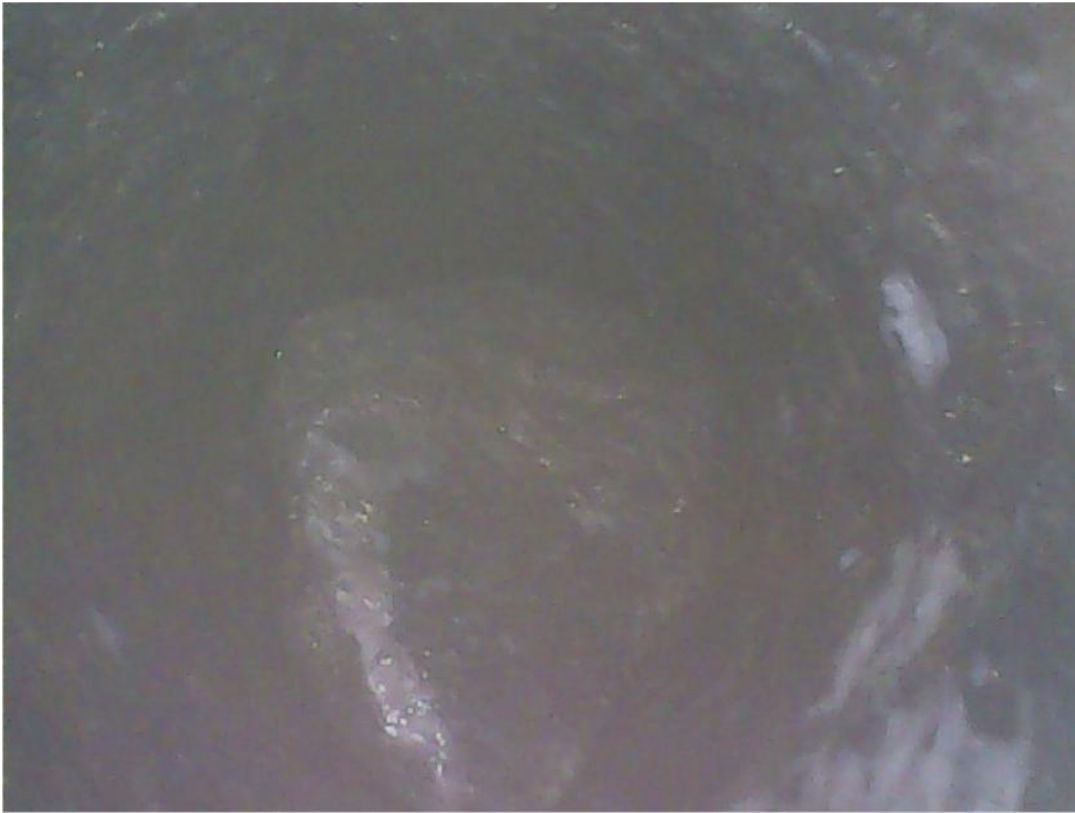
The objective is to continue mapping a sample group of each drill hole position on the face, in different types of material which at Coleman includes:

- Rock (Waste)
- Ore (Nickel, Copper, Sulphide)
- Cemented Sand (Stope Pillars)

To date 60 jumbo drill holes have been mapped and recorded to the attached spreadsheet, this includes:

- Video and comments where a condition including loose exists in the hole
- Photographs of isolated loose in the hole
- Orientation and Direction of the drill hole
- Depth of the drill hole
- Position of the hole on the face
- Profile of the face and all collars
- The marking of the face (grid at collars of holes)

An early example of the types of loose material found in drill holes in Ore are shown in Figure 11, and an early example of the extent of damage to the drill holes in Rock are shown in Figure 12.



**Figure 11: Ore Chunk Blocking Drill Hole at 11 Feet Depth.**





**Figure 12: Typical Damage to Drill Hole Walls in Rock (Waste)**

#### **INDEX OF MAPPING DATA AND VIDEOS:**

A thorough summary of the data gathered is available through the website. Not all raw data is on the website, but is recorded and can be requested. There is an index on the website of all total data available.

There is an email request form for data on the Remote Loading webpage. Contact telephone numbers are also included.

#### **PRESENT CONCEPTUAL LOADING BASKET BOLT ON CLEANING SOLUTIONS:**

#### **SAFETY REVIEW OF PRE AND POST DRILL HOLE CLEANING REGULATIONS:**

There are two elements to the safety aspect reviews related to this project:

- The involvement of the Coleman Mine OSHE Committee
- The Vale Safety Department

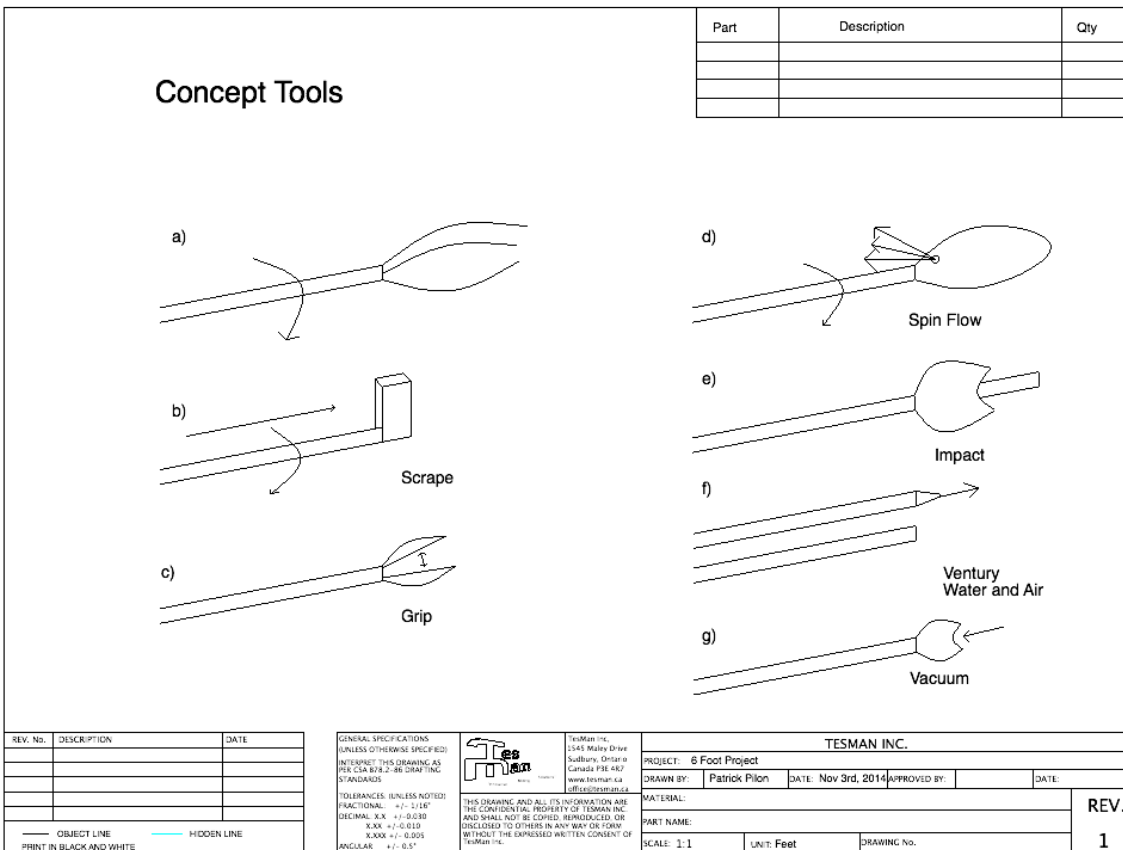
In the first project phase, the Vale Safety Department investigated the risks related to mechanically feeding a shock tube initiating cap system into a drill hole for loading ANFO or Emulsion. The solutions were identified as:

- The mechanical feed system having a limited feed ability capped at 50% of the shock tube suppliers recommended shock tube stretch risk threshold
- A plastic tab type process connecting the shock tube cap to the end of the loading hose, that would fail, like a fuseable link, at the same 50% force value supplied by the shock tube supplier

In this second project phase, the same Vale Safety Department Team are investigating the company, provincial and federal rules and regulations, related to the mechanical cleaning of drill holes after drilling, and also after blasting if explosive product and or caps have to be removed.

The team are scheduled to provide their first findings in December. From there a set of solutions to be incorporated in the prototype technology will be suggested, reviewed and incorporated.

**CONCEPTUAL CLEANING TOOLS TO TEST:**

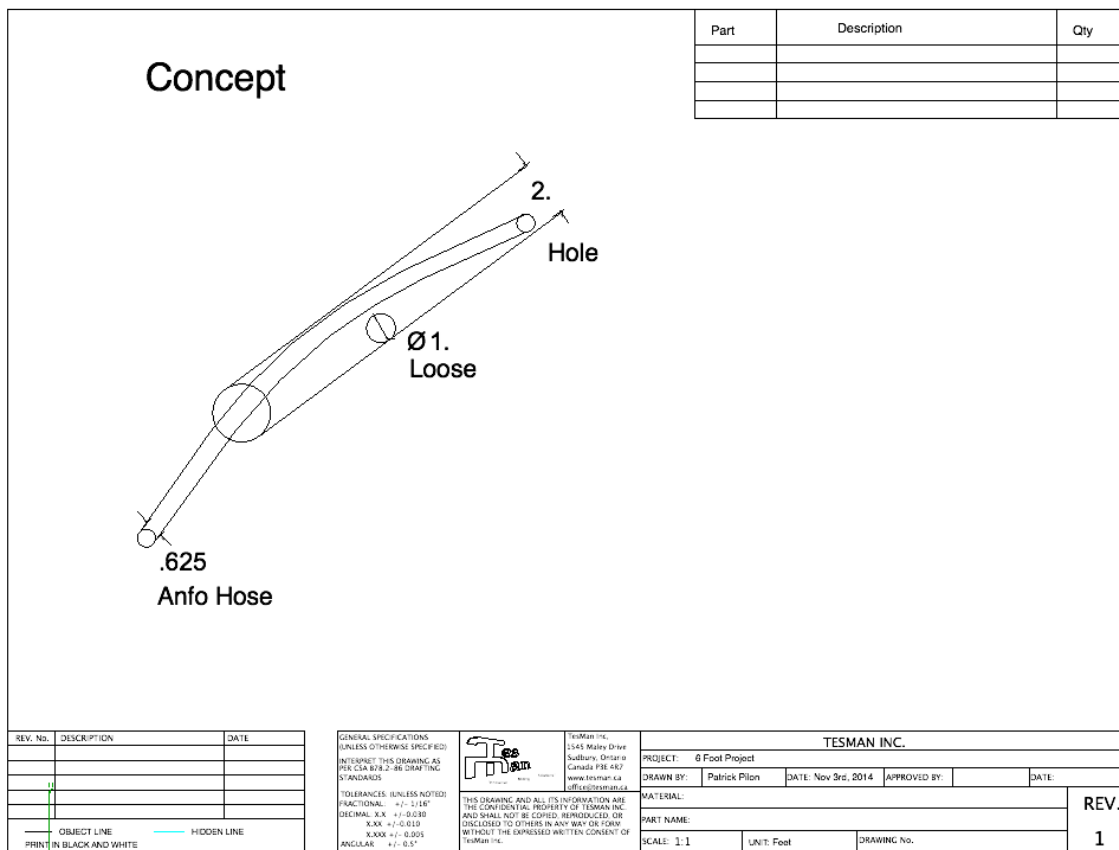


**Figure13: Down the Hole Cleaning Tool Concepts**

In line with the observed conditions, keeping the tools simple, and the loaders needs in mind (described above), a series of conceptual down the hole tools is evolving. These are briefly captured in Figure 13. These concepts will be tested for effectiveness and the best solutions fabricated for use in the field:

- a) A simple rotating pitch fork (more suitable to cemented sand loose in hole)
- b) A simple scraper (similar to present 4 foot scraper in use) with feed, retract and rotation capability
- c) A claw
- d) A back spray / mist / air fines remover
- e) An impact tool to break larger chunks to remove or just to allow loading hose to pass (see Figure 14)
- f) A venturi process to remove extreme mud and water mixtures
- g) A vacuum to extract chunks

To be clear, this list will grow, and it is unlikely that the final product will require more than a few of these options.



**Figure14: Moving 5/8 Loading Hose Around Chunk Less Than 50% Hole Diameter**

The next stage of development is to have all of these tools be quick fit coupling capable, to test on the end of the present endoscope auditing tool.

#### **EQUIPMENT SUPPLIER PROGRESS TODATE:**

NORMET and ATLAS COPCO participated through the project from the start, and ultimately are aiming to generate their own commercial products for the worldwide market, to allow remote development, to complement their present product lines.

These companies are joining the technical committee review of the work packages completed and those being planned.

#### **WEBSITE COMMUNICATION TOOL:**

The website will be redesigned to accept the Monthly Work Packages by mid November. The Link to this page will be distributed at that time.

#### **DATABASE ANALYSIS:**

All data related to the drill holes is being recorded, organized and stored in a library. The first analysis of this information will be presented in the November Work Package.

Approved monthly work packages will be uploaded to this page the end of the first week of each month.

## Milestones for November's Work Package

- NOVEMBER WORKPACKAGE
- UPDATE MAPPING OF DEVELOPMENT (LOADING) PROCESS & PROTOTYPE CYCLE DETAIL
- CONTINUE UG MAPPING OF DRILL HOLE CONDITIONS COLEMAN MOB
- CONTINUE EVOLUTION OF HOLE MAPPING EQUIPMENT (SCOPE )
- COMPLETE FIRST ANALYSIS OF ROCK, ORE, SAND DRILL HOLE LIBRARIES
- ORDER COMPONENTS FOR CONCEPTUAL CLEANING TOOL FOR MANUAL TESTING
- DETAIL THE CLEANING TOOL HEAD CONCEPTS FOR FABRICATION QUOTING
- DETAIL THE CONCEPTUAL BOLT ON TOOL FOR QUOTING
- AWARD SUPPLIER QUOTES (BOLT ON FEED ARM DESIGN ONLY DECEMBER 31, CLEANING HEAD CONCEPTS DESIGN DECEMBER 31, FIBRE OPTIC ENDOSCOPE AVAILABLE OPTIONS DECEMBER 31)
- PUSH FIRST WORK PACKAGE UP TO WEBSITE AND MAIL THE LINK
- INTRODUCE OTHER REMOTE LOADING MINE MANAGERS TO OWNERS
- SETUP EQUIPMENT SUPPLIER TECHNICAL CONTRACTS (AND REPRESENTATIVES) WITH VALE PURCHASING
- DETAIL PORTABLE FEED TOOL AND GET SUPPLIER FABRICATION QUOTE (TO BE DESIGNED TO BE UNDER BOOM LIFTING CAPACITY)
- REVIEW SAFETY DEPT INVESTIGATION REGARDING PRE AND POST CLEANING

## **Milestones for Future Work Packages (In Development)**

### **DECEMBER WORK PACKAGE:**

- FABRICATE THE PORTABLE FEED (AND ROTATION) HAND TOOL
- FABRICATE AND UG TESTING OF FIRST MANUAL CLEANING TOOLS
- COMPLETE DESIGN CONCEPTS OF FIXED FEED TOOL FOR BOLT ON ARM
- REVIEW AND UPGRADE BOLT ON FEED ARM DESIGN PACKAGE
- PUSH WORK PACKAGE UP TO WEBSITE

### **JANUARY WORK PACKAGE:**

- UG TESTING OF THE PORTABLE FEED (AND ROTATION) HAND TOOL
- UG TESTING OF CLEANING TOOLS IN PORTABLE FASHION
- COMPLETION OF AVERAGE CYCLE TIMESTUDY TO COMPARE TO PLAN CYCLE
- QUOTE FROM SUPPLIER FOR FAB OF FIXED FEED TOOL FOR BOLT ON ARM (TO INCLUDE MECHANICAL LOADING SAFETY FEATURES AS WELL AS MECHANICAL CLEANING SAFETY FEATURES)
- DESIGN FOR QUOTE OF ADDITIONAL CLEANING TOOLS
- QUOTE FROM SUPPLIER FOR FAB OF ADDITIONAL CLEANING TOOLS
- PROGRAM PERSONNEL FACE SCAN LIDAR FOR PROTOTYPE CYCLE
- IDENTIFY TRANSFERABLE TECHNOLOGY LOCATIONS & SCHEDULE A VISIT
- PUSH WORK PACKAGE UP TO WEBSITE

**FEBRUARY WORK PACKAGE:**

- DECISION ON FLUSHING DATA AVAILABILITY FOR CYCLE & QUOTE
- PRE AWARD WORKSHOP WITH LOADERS ON DESIGN PACKAGE FOR ARM
- AWARD FABRICATION OF BOLT ON ARM WITH FEED (AND ROTATION)
- AWARD FABRICATION OF ALL CLEANING TOOLS FOR BOLT ON FORMAT
- PROGRAM TOUCH SCREEN FOR LOADING ARM CONTROL (AND DEPTH)
- COMPLETE THE DESIGN OF THE PROTOTYPE WORK CYCLE WITH COMPARATIVE TIMES
- COMPLETE THE LOADING CAUSE PACKAGE (EX RELATIVE FACE, OVERLAP, DEPTH CLEANED, PROPOSED TIMING )
- PUSH WORK PACKAGE UP TO WEBSITE
- SCHEDULE FIELD TRIPS TO TRANSFERABLE TECHNOLOGIES

**MARCH WORK PACKAGE:**

- UG TESTING OF BOLT ON REMOTE CLEANING ARM, TOOLS AND SCREEN
- WORKSHOP REVIEW THE PROTOTYPE WORK CYCLE WITH THE CREWS
- PRACTICE RUNS OF PROTOTYPE CYCLE TO DEVELOP PROCEDURES
- PUSH WORK PACKAGE UP TO WEBSITE

**APRIL WORK PACKAGE:****MAY WORK PACKAGE:****JUNE WORK PACKAGE:**

