Use of Ton Mile formula.

To convert the use of lbs. & ft. as used on the rig to ton-miles we need a conversion factor:

\[ \Rightarrow 2000 \text{(lbs. in a ton)} \times 5280 \text{ (ft. in a mile)} = 10 560 000 \]

To understand this figure it may be useful to realise that if you pick up or lower a 1 lbs. Wt.10 560 000 ft. it is equivalent to 1 Ton Mile.

By a similar argument if you have a wt. Of 10 560 000 lbs. and ether picked up or lowered it 1 ft. it to is equivalent to doing 1 Ton Mile of work.

The formula.

\[ \frac{D \times (D + L) \times BWS}{10 560 000} + \frac{(1/2 \text{BHA} + \text{TBW}) \times D}{2 640 000} \text{ For Tripping Ton Miles} \]

\[ \frac{D \times (D + L) \times BWS}{10 560 000} + \frac{\text{TBW} \times D}{2 640 000} \text{ For Csg. Ton Miles} \]

D - Distance of trip.
L - Length of tubular being used (i.e. 43’ for Csg. Or 95 ‘ for d.p.).
BWS – Boyd wt. Of string in mud.
(1/2 BHA)-Bottom hole Assembly Wt. Only to be used in conjunction with Drilling
TBW- Travelling Block Wt.

This gives you Ton Miles for a round trip. It must be **HALVED** for a one way trip i.e. Csg.

To understand the formula we will consider the Left Hand Side and the Right Hand Side of it separately.

**The R.H.S. first:** - this gives you the work done in Ton Miles for moving the blocks during tripping operations, in the case of Drilling Ton Miles it accounts for the additional burden of the B.H.A.

To round trip a string the blocks will travel a distance of 4 times the depth of the hole.

i.e. to round trip one stand: - Blocks go up derrick & p/up stand.
    Blocks go down derrick r.i.h.
    Blocks go up derrick p.o.o.h.
    Blocks go down derrick to starting point.

The work done lifting and lowering the blocks whilst tripping just one stand of pipe can be calculated as follows:

The Wt. of the travelling block times the distance it travels times four = 120 000 lbs. x 95 ft. x 4
\[ = 120 \times 380 \]
\[ = 45 600 000 \text{ ft./ lbs. work for a round trip} \]
This figure is divided by the conversion factor:  

\[
45,600,000 / 10,560,000 = 4.32 \text{ Ton Miles work for round trip}
\]

This half of the formula could be written,

\[
\left( \frac{T.B.W. \times D}{10,560,000} \right) \times 4
\]

But can be simplified by instead of multiplying the product of the brackets by 4, dividing 10,560,000 by 4 as follows.

\[
\frac{T.B.W. \times D}{2,640,000}
\]

If a B.H.A. is involved it is only burdening the blocks for two of the four passes the blocks make of the derrick, hence only adding \( \frac{1}{2} \) B.H.A. to the T.B.W.

**The L.H.S. now-** This side of the formula works out the Ton Miles accumulated by hoisting and lowering the weight of the tubules.

Consider a round trip of 500 ft. using stands of 100 ft. length that weigh 20 lbs. per ft. i.e. 1 St. weighs 2000 lbs. in mud.

<table>
<thead>
<tr>
<th>Lower wt. of</th>
<th>1 st. 100 ft.</th>
<th>2 000 x 100 = 200 000 ft. / lbs. work.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower wt. of</td>
<td>1+2 st. 100 ft = 4 000 x 100 = 400 000 “</td>
<td></td>
</tr>
<tr>
<td>Lower wt. of</td>
<td>1+2+3 st. 100 ft = 6 000 x 100 = 600 000 “</td>
<td></td>
</tr>
<tr>
<td>Lower wt. of</td>
<td>1+2+3+4 st. 100 ft = 8 000 x 100 = 800 000 “</td>
<td></td>
</tr>
<tr>
<td>Lower wt. of</td>
<td>1+2+3+4+5 st. 100 ft = 10 000 x 100 = 1 000 000 “</td>
<td></td>
</tr>
</tbody>
</table>

N.B. Each consecutive stand has the wt. of the previous stands attached. Total: -3 000 000 x 2 to complete the round trip.

6 000 000 ft. lbs. work on line.

To convert this to Ton Miles, divide this by the conversion factor:  

\[
\frac{6,000,000}{10,560,000} = 0.57 \text{ Ton Miles work for round trip}
\]

If we use the formula to simplify the maths:  

\[
\frac{D \times (D + L) \times BWS}{10,560,000} = \frac{500 \times (500 + 100) \times 20}{10,560,000} = 0.57 \text{ Ton Miles work for round trip}
\]

On the same trip the blocks would have contributed:  

\[
\frac{TBW \times D}{2,640,000} = \frac{120,000 \times 500}{2,640,000} = 22.73 \text{ Ton Miles work for round trip}
\]

Total Ton Miles for a round trip of 500ft. = 22.73 + 0.57 = 23.30 Ton Miles work for Round trip

As can be seen at shallow depths heavy blocks have a significantly greater affect on Ton Miles clocked up, as does the weight of the pipe being moved.
Drilling Ton-Miles.

Drilling ton miles are arrived at by:

Firstly calculating the round trip Ton Miles at the depth you start drilling and subtracting this figure from the round trip Ton Miles at the depth you finish drilling.

Then secondly multiplying this figure, traditionally by three or if you were coring, by two.

The need to multiply the Ton Miles can be explained as follows:

Drilling with a Kelly can be broken down into six operations, each operation placing ½ a round trip work on the line. The total of which would require three round trips for every single drilled.

1<sup>st</sup> The Kelly is drilled down plus or minis 31 ft.
2<sup>nd</sup> The Kelly is back reamed plus or minis 31 ft.
3<sup>rd</sup> The Kelly is reamed down plus or minis 31 ft.
4<sup>th</sup> The Kelly is pulled back up plus or minis 31 ft., the slips are set & the Kelly is broken off
5<sup>th</sup> The Kelly is made up to the single in the mouse hole, and then lifted up a further 31 ft.
6<sup>th</sup> The new single is made up to the string and the string is lowered back down 31 ft. to the bottom.

N.B. If hole conditions require additional reaming, each additional ream will add one more round trip over that section.

The reason Coring Ton Miles are only multiplied by two, is because during this operation the string is not usually back reamed if it can be avoided, thereby reducing the chance of losing the core being collected.

Drilling with a Top Drive however can be broken down into four operations, each operation placing ½ round trip work on the line. The total of which would require two round trips for every stand drilled.

1<sup>st</sup> The stand is drilled down.
2<sup>nd</sup> The stand is back reamed.
3<sup>rd</sup> The stand is reamed down again.
4<sup>th</sup> The Top Drive is broken off, and the blocks go up for the next stand, drilling re-commences

And finally it is important to realise that the measuring and recording of Ton Miles is not a direct, but an indirect indication of the work and wear that your line has done. It does not take into account shock loads, hard braking or damage being done by sheaves or spooling on the drum. The life expectancy of your line can only be fully assessed by full inspection of the line that is cut off during your slip and cut routine.

The entire piece, as well as the individual strands that make up the line is inspected for corrosion and how much tar lubrication is remaining. Testing includes amongst other things measuring the lines, flexibility (both twisting and bending), its ability to stretch under load, and recover to its original length, and ultimately full destruction testing to identify the load it will brake at. It is important to realise that a high braking strain on its own is not necessarily a good sign, a work hardened line can have a high braking strain but have exceeded its life expectancy, caused by its reduced ability to bend or stretch.
It is through these inspections that you have to be prepared adjust at how many Ton-Miles you perform your slip and cut routine.