8. What actual horse-power will be realised by a water-pressure engine having an efficiency of 78 per cent., with two sluice-heads of water and 380 ft. hydraulic head?

$$\frac{2 \times 380}{11{\cdot}282} = 67{\cdot}36\text{-horse power.}$$

The more complicated rules given in Gordon's "Miners' Guide," "Molesworth," and other works on hydraulics produce the same results as in the above examples.

Calculation of the Carrying-capacity of Open Channels, Tunnels, and Flumes by Eytelwein's General Formula.

"The mean velocity of water in feet per second equals the square root of twice the fall in feet per mile multiplied by the hydraulic mean depth in feet."

And velocity multiplied by area equals quantity.

The hydraulic mean depth is the sectional area of flowing water divided by the wetted border.

The area is the mean width of the flowing water multiplied by its depth.

The wetted border is readily found for plumb or sloping sides by the following rules:—

Plumb sides	Depth × 2	+ width of bottom.
¼ to 1 sides	Depth × 2·0615 +	"
½ to 1 sides	Depth × 2·236 +	"
1 to 1 sides	Depth × 2·828 +	"

Example 1.

What quantity of water will a channel with ¼ to 1 sides carry, 4 ft. wide at bottom, 2 ft. 6 in. depth of water, and having a gradient of 12 ft. per mile?

$$(2{\cdot}5 \times 2{\cdot}0615) = (5{\cdot}15375) + 4 = 9{\cdot}15375 = \text{wetted border.}$$

$$\frac{5{\cdot}25+4}{2} = 4{\cdot}625 = \text{mean width.}$$

$$4{\cdot}625 \times 2{\cdot}5 = 11{\cdot}5625 = \text{area.}$$

$$\frac{11{\cdot}5625}{9{\cdot}15375} = 1{\cdot}2631 = \text{hydraulic mean depth.}$$

$$\sqrt{24 \times 1{\cdot}2631} = 5{\cdot}5058 = \text{velocity in feet per second.}$$

$$5{\cdot}5058 \times 11{\cdot}5625 = 63{\cdot}66 = \text{quantity in cubic feet per second.}$$

The number of cubic feet per second (or sluice-heads) of water which such a channel will carry, if long, straight, and smooth, is 63·66, but for other kinds of channels the result must be multiplied by coefficients suitable to the character of the channels, as a crooked and rough ditch or tunnel through boulders and stones, or with sets of timber every 3 ft. or 4 ft., will only carry about 40 per cent. of that quantity.

The following table of coefficients for flumes, tunnels, and channels is deduced from a large number of experiments extending over a period of twenty-five years:—

1. Iron fluming straight and smooth	1·0
2. Iron fluming moderately straight and smooth	0·9
3. Flumes and tunnels straight, and lined with dressed boards	0·8
4. Flumes and tunnels straight, and lined with sawn boards	0·7
5. Clay smooth and moderately straight	0·6
6. Gravel moderately rough, with easy curves	0·5
7. Boulders, or with sets of timber and bad curves	0·4

So that a channel of the dimensions and gradient given in the above example will carry the following quantities of water, according to the character of the material of which its wetted border or frictional surface in contact with the flowing water is composed:—

No. 1 character	63·66	sluice-heads.
No. 2 "	63·66 × 0·9 = 57·29	"
No. 3 "	63·66 × 0·8 = 50·92	"
No. 4 "	63·66 × 0·7 = 44·56	"
No. 5 "	63·66 × 0·6 = 38·19	"
No. 6 "	63·66 × 0·5 = 31·83	"
No. 7 "	63·66 × 0·4 = 25·46	"

This is for long lengths, or lengths sufficient to allow the flowing water to acquire its proper train. Short lengths of fluming between tunnels or ditching should in all cases have the same sectional area and as near as possible the same form of flowing water as the tunnels or ditching, and the same gradient. All changes in the form of the sectional area of flowing water should be made gradually.

Example 2.

What quantity of water will a channel carry with side slopes ¼ to 1, 6 ft. width of bottom, 3 ft. depth of water, and a gradient of 4 ft. per mile?

$$(3 \times 2{\cdot}0615) = (6{\cdot}1845) + 6 = 12{\cdot}1845 = \text{wetted border.}$$

$$\frac{6+7{\cdot}5}{2} = 6{\cdot}75 = \text{mean width.}$$

$$6{\cdot}75 \times 3 = 20{\cdot}25 = \text{area.}$$

$$\frac{20{\cdot}25}{12{\cdot}1845} = 1{\cdot}6619 = \text{hydraulic mean depth.}$$

$$\sqrt{8 \times 1{\cdot}6619} = 3{\cdot}646 = \text{velocity in feet per second.}$$

$3{\cdot}646 \times 20{\cdot}25 = 73{\cdot}83$ = cubic feet per second (or sluice-heads)—if in long, straight, and smooth iron fluming. If in gravel moderately rough with easy