

Quick Reference Guide to Antenna Selection for NERC GEF GPR Systems

As a rough guide, vertical resolution in the ground can be estimated as being one quarter of the wavelength (λ):-

$$\lambda = V / f$$

Where V is the velocity and f is the frequency. The following tables show examples for both GEF radar systems in various materials. Table 3 gives further values of material properties.

| Pulse EKKO 100 | 50 MHz | 100 MHz | 200 MHz |
|---------------------------------|--------|---------|---------|
| Soil (V=0.075 m/ns) | | | |
| Wavelength (cm) | 150 | 75 | 37.5 |
| Resolution (cm) | 37.5 | 18.75 | 9.4 |
| Limestone (V=0.110 m/ns) | | | |
| Wavelength (cm) | 220 | 110 | 55 |
| Resolution (cm) | 55 | 27.5 | 13.75 |
| Ice (V=0.150 m/ns) | | | |
| Wavelength (cm) | 300 | 150 | 75 |
| Resolution (cm) | 75 | 37.5 | 18.75 |

Table 1

| Pulse EKKO 1000 | 225 MHz | 450 MHz | 900 MHz |
|---------------------------------|---------|---------|---------|
| Soil (V=0.075 m/ns) | | | |
| Wavelength (cm) | 33.3 | 16.7 | 8.3 |
| Resolution (cm) | 8.3 | 4.2 | 2.1 |
| Limestone (V=0.110 m/ns) | | | |
| Wavelength (cm) | 48.9 | 24.4 | 12.2 |
| Resolution (cm) | 12.2 | 6.1 | 3.0 |
| Ice (V=0.150 m/ns) | | | |
| Wavelength (cm) | 66.7 | 33.3 | 16.7 |
| Resolution (cm) | 16.7 | 8.3 | 4.2 |

Table 2

Dielectric Properties of Typical Materials

| Material | Relative Dielectric Constant ϵ_r | Velocity (m/ns) |
|-----------------|---|------------------------|
| Air | 1 | 0.30 |
| Water (fresh) | 81 | 0.033 |
| Water (salt) | 81 | 0.033 |
| | | |
| Snow | 1.4 – 3 | 0.194 – 0.252 |
| Pure Ice | 3.2 | 0.167 |
| Sea Ice | 2.5 – 8 | 0.078 – 0.157 |
| | | |
| Sand (dry) | 10 | 0.075 |
| Sand (wet) | 25-30 | 0.055 – 0.060 |
| Silt (wet) | 10 | 0.095 |
| Clay (wet) | 8 – 15 | 0.086 – 0.110 |
| Clay soil (dry) | 3 | 0.173 |
| | | |
| Limestone | 7 – 9 | 0.100 – 0.113 |
| Sandstone (wet) | 6 | 0.112 |
| Concrete | 6 – 30 | 0.055 – 0.112 |
| | | |

Table 3