The Burnham Observatory
Estimated Costings & Design Brief

The Burnham Observatory is a simple, inexpensive concept that uses an existing structure to provide residents and visitors with an insight into the river, the tides and the sky above them.

Information ranges from how you tell if the tide is coming in to how you tell where the moon is on its monthly orbit round the earth.

Primarily, it celebrates one of town's biggest attractions – Burnham's spectacular sunsets, which are among the best in the country.

It will be located at 'Sunset Point' which terminates West Quay and marks the eastern entrance to the marina (see picture below).

Sunset Point is a great place to watch sunrise and sunsets, especially in spring, autumn and winter.

The key feature will be the Sunset Protractor, which will allow visitors to watch the setting sun drop into a different notch for each day of the year – an awe-inspiring and educational phenomenon that can be found at ancient observatories around the world.

This magic of the installation is that it vividly describes our place in our orbit around the sun.

The idea is to communicate the physical sensation of being on a rotating planet in orbit around its sun – to give visitors astronomical awareness in the context of Burnham and so create a memorable learning experience. The Burnham Observatory will be of interest to school children, residents and visitors alike. It is a potential tourist attraction and fits neatly into the Saltmarsh Trail.

The Burnham Observatory at Sunset Point

Features

1. The Sunset Protractor will be attached to the top rail.
2. There will be a floor diagram of the earth's Orbit.
3. There will be information boards on either side of the path – the Information Avenue.

COST ESTIMATES

The total budget, including installation, is £20k
All elements to be as vandal-proof and weatherproof as possible.
All prices are ex-VAT, which, presumably, can be claimed back?

	Title	Detail	Est. Cost
1.	**Design & Writing** of all elements	A design brief can be supplied for quotations.	3000
2.	**Sunset protractor** - Navigational expert	To ensure all 183 markings are aligned exactly to the Burnham sunsets.	500
3.	Sunset Protractor – Information board manufacture	1 ft x 1.5 ft stainless steel plate, inscribed with text.	1000
4.	Sunset Protractor – manufacture & installation	8 ft x1 ft curved, stainless steel plate, including inscribing as necessary. Secured to existing sunset point top railing with u-clamps and security bolts.	1500
5.	**Floor Diagram** manufacture	Designed to be walked upon. Includes Earth's orbit diagram, information plate and a compass rose – possibly printed on a 10mm metal disc, say 4 ft diameter. Or a stainless frame filled with resin under which the design will be printed on a plastic base.	2500
6.	Floor Diagram installation	Including resurfacing part of the base to accept the Floor Diagram.	1000
7.	**Information Boards** – Manufacture	8 vandal-proof colour-printed boards – possibly on 2 mountings, each on either side of the path and adjacent to Sunset Point.	9000
8.	Information Boards – installation		1000
	Contingency		500
	TOTAL		20000

Note – ALL TEXT & DESIGNS are indicative & draft only.
They are designed to explain the concept.
The writer must work in close cooperation with the designer to make this project work well.

Draft text for Sunset Protractor Information Plate

The Burnham Observatory at Sunset Point

Burnham-on-Crouch, with its sweeping river view, flat vistas and big skies, enjoys some of the warmest weather and the best sunrises and sunsets in Britain.

Many international travellers have said they've seen their most beautiful sunsets here.

The Sunset Protractor
The key part of this installation is the Sunset Protractor, which features three sunset marker arrows pointing to the where the sun sets during the spring and autumn equinoxes (see floor diagram for an explication).

It also indicates the point on the southern shore, behind the Wallasea Marina, where the sun reaches the winter solstice, and the place north east of Creeksea Woods where it reaches the summer solstice.

It also features a notched rim so that you can watch the sun set in a different notch each day, tracking the movement of the sun as it journeys northwards after the winter solstice (21st December), the sun setting just a little further north each day, and southwards after June 21st, the summer solstice, when it begins its return journey towards winter's shorter days and longer nights.

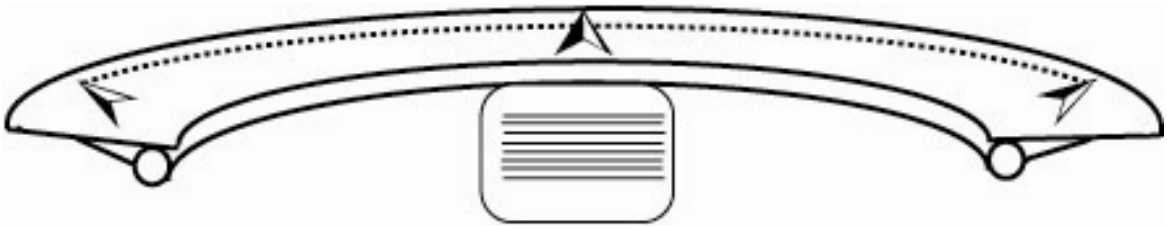
Sunset colours are caused by sunlight coming through the atmosphere at a low angle. The atmosphere acts like a prism, dividing the sky into various, and often glorious, colours.

Dry Burnham
Burnham is one of the warmest and driest places in Britain. This is because the westerly winds bringing rain off the Atlantic have dumped most of it before it gets here.

And, you will notice, the Crouch often conducts its own little piece of magic at Burnham – often you can stand here and see curtains of rain all around you, while Burnham remains uncannily dry.

If you are reading this in the rain, our apologies – it's doesn't always work…

SUNSET PROTRACTOR with information plate



The sketch above shows a stainless steel or brass plate to be attached to the outside of the existing black rails. (See picture on page 1)

The etched arrow heads represent the marks showing the direction of the setting sun on the winter solstice (left), the spring and autumn equinox (middle) and the summer solstice (right).

The dotted line represents 183 days of the year – each to be marked with the two dates that the mark aligns with the setting sun on its journey south and north.

Further text (see previous page) will be on the plate suspended from the Sunset Protractor.

***Note- not shown** is the vertical plate on the outer edge, like a rim or lip, which will have 183 notches it (or the number required by the navigational expert).*
This is so that people can watch the sun drop into each notch on any given day.

IE the sun will fall into each notch twice a year (there being 365 days in a year).

The summer sunsets fall behind Creeksea woods – but the notches should still be there even though the trees will prevent people seeing the sun hit the horizon.

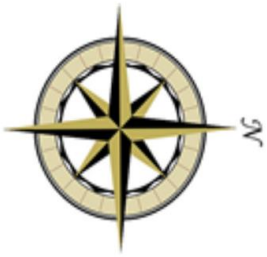
NOTE ON THE ORBITAL DIAGRAM AND THE INFORMATION AVENUE

The following pages include text and illustrations proposed for an avenue of information boards that will border the path to the Observatory at Sunset Point. **These are indicative only.**

The final information boards will have less information on them but will have QR codes directing people to more information on the Burnham Town Council website via their mobile devices.

The final illustrations will be professionally executed**.**

FLOOR ORBITAL DIAGRAM
(surrounded by dates)



Spring (vernal) Equinox – (20 March)
The night is 12 hours long. So is the day. They are equal – hence the name, Equinox.

Earth

Direction of the Earth along its orbit

Summer solstice
(21 June)
Longest Day - shortest night. When the sky is clear, it's only really dark between midnight and 3am.

Sun

Perihelion
(the point where Earth is *closest* to the sun)

Aphelion
(the point where Earth is *furthest* from the sun)

Winter solstice
(21 December)
Shortest Day.
The sun rises after 8am and sets before 4pm.

Autumnal equinox
(22 September)
The night is 12 hours long. So is the day. They are equal – hence the name, Equinox

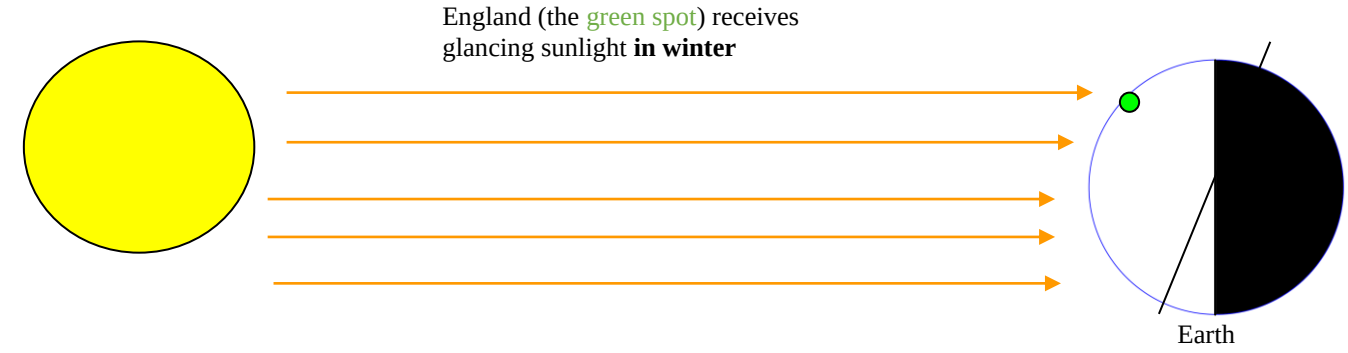
FLOOR TEXT

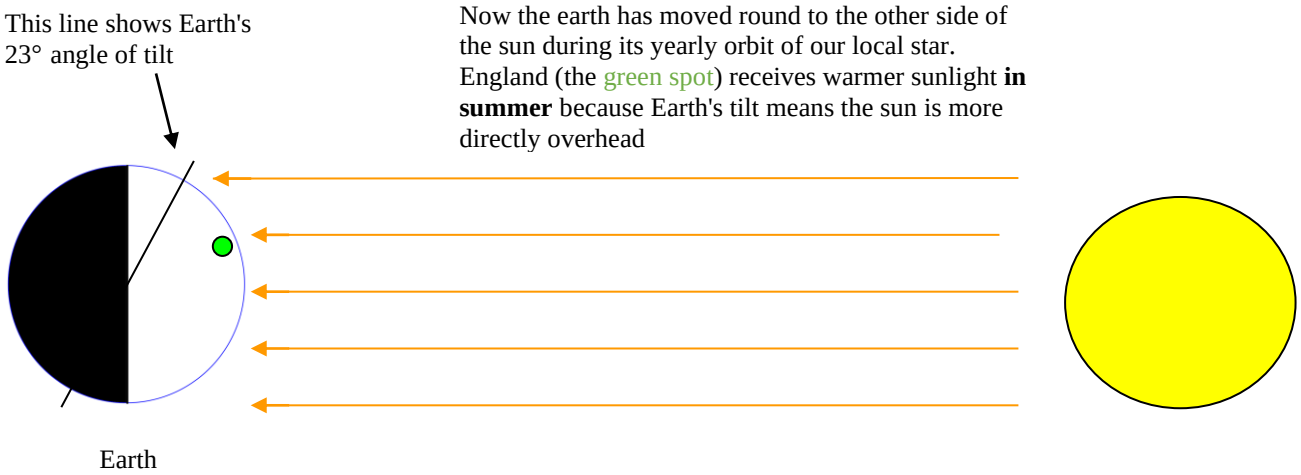
TURNING BURNHAM

- As you stand here, *look towards the town* – you are looking east.
- When you look east you are looking towards the North Sea and Holland.
- Look west (behind you) and you are looking towards Creeksea.
- 21 miles away as the crow flies is Brentwood.
- London is about 40 miles to the west southwest. Chelmsford is 16 miles to the northwest.
- You can see the tower blocks of Southend if you look west of south. They are 7 miles away.
- **The world is turning**. As you look east, you are moving in that direction at about **600 mph**.
- At the equator you'd be moving at around 1000mph, but Burnham is much further up the curve of the Earth, so we have less distance to go during the daily rotation of the Earth. Put it another way, the circumference of the Earth is much shorter at Burnham's latitude than it is, say, at Singapore's.
- So if you think you are standing still, you aren't… You are on a curved world turning eastwards over the horizon.
- This is why the sun appears to rise in the east and move over the sky to set behind you, in the west. The sun isn't moving relative to us – it just feels that way because the Earth rotating, once a day.
- While the Earth turns on its axis, it is also flying along its orbit. It takes one year to go round the sun.
- **Our orbit** is elliptical - like a stretched circle. This is because of gravitational effect:
- If you throw a ball, it follows the path of an elliptical curve, or, more specifically, a parabola. As it flies, the ball is constantly pulled towards the centre of the Earth by gravity, until, of course, it hits the ground.
- You'd have to throw it out of the atmosphere, at over 18,000 mph (escape velocity), to get it moving fast enough that it didn't hit the ground again. You'd have to escape the atmosphere to avoid air resistance.
- This is called **free fall** because the ball is going so fast it doesn't land; it is still 'falling, but 'free', not hitting the ground. It would be orbiting the Earth like a rocket. If you were thrown at that speed in a rocket, you would feel weightless.
- Anything captured gravity will usually be pulled into a parabolic orbit.
- Because there is no air resistance in the vacuum of space, Earth will continue to orbit for billions of years. There is little but space dust and the occasional rogue asteroid to slow Earth down. The Earth is, slowly, slowing down.
- **Earthspeed:** The Earth is flying along its orbital path at around 67,000 mph.
- **Sunspeed:** The sun and the solar system are collectively orbiting the supermassive black hole at the centre of our galaxy (the Milky Way) at around 500,000 mph.
- **Galactic speed**: The galaxy itself is motoring along at some 1.3 million mph. Everything in the universe is on the move, even if it thinks it isn't. Nothing stands still.

Seasons & the tilted Earth

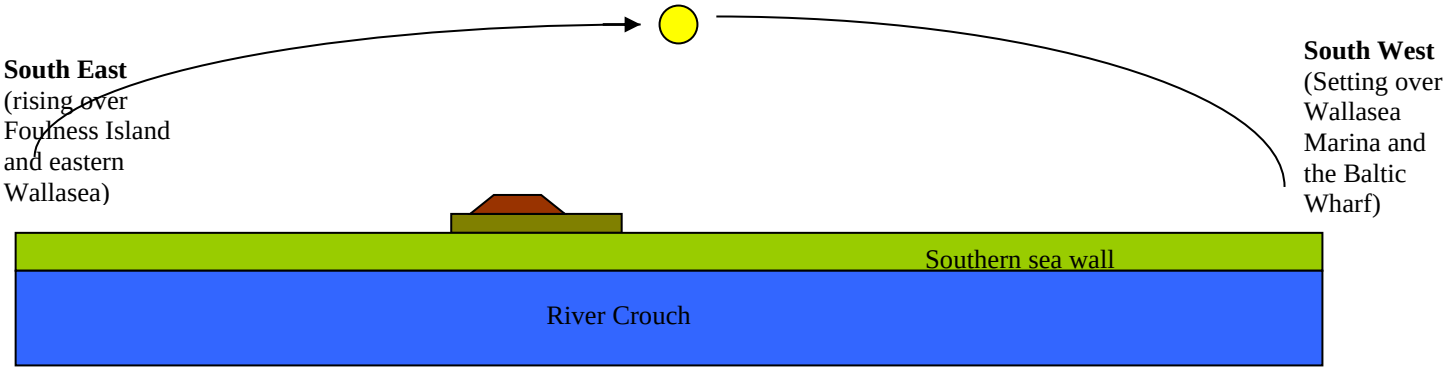
- The Earth spins like a tilted top, making a complete turn every day. So the **green spot**, which represents the UK, returns to the same position once every 24 hours.
- The earth has a circumference of just under 24,000 miles. With 24 hours in a day, that means it turns at (just under) 1000 miles an hour.
- Earth is *tilted* over at an average 23° from the upright, and spins like a leaning top.
- **In winter**, during daylight, England is leaning away from the sun, and this makes the sun appear low in the sky (see diagram of the river below).
- Because the sun is lower, we get less direct heat from it – it glances off us.
- But **in summer**, when we are on the other side of the sun in our orbit, we are more titled towards the sun. (You can see from the second diagram below that the **green spot** is getting more direct sunlight).
- That makes the sun appear higher in the sky, and so we see it in the sky for longer, which is why the days are longer in the summer. With the sun's rays falling more directly on top of us and not glancing past us, it means it's hotter in summer.
- And because we get longer days in summer, we get much more sunlight and heat than we do in the short days of winter. That's why summer is warm and winter is cold. And why Australia has winter when we have summer.
- **It's got nothing to do with how far we are from the sun.** In fact, (in England and the rest of the northern hemisphere) we are closer to the sun in winter than summer. The seasons are created by the way the earth is tilted over on its axis, not by our relative distance to the sun.
- **The sun is 93 million miles away.** It's about a million times bigger than Earth. It takes light, travelling at 12 million miles a minute, around 8½ minutes to reach us from the sun. So if the sun blew up, we wouldn't see it for 8½ minutes.



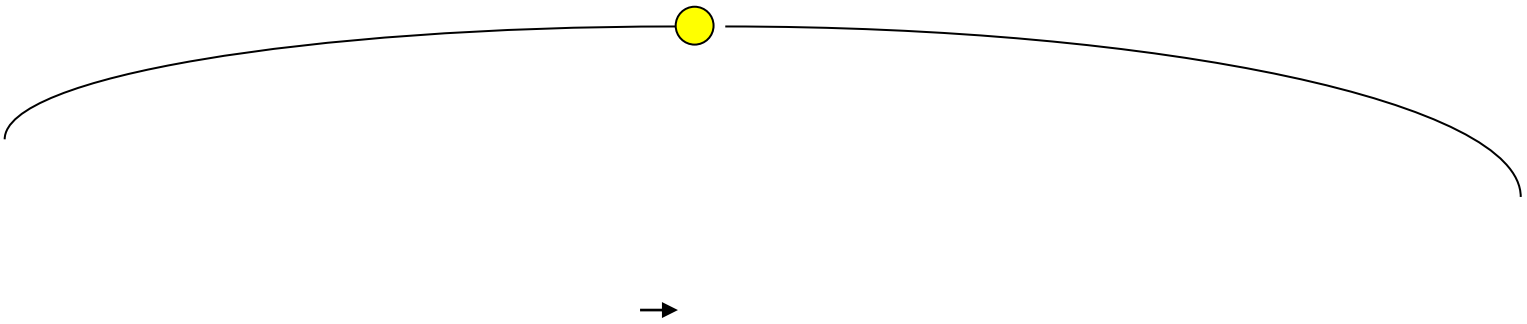


INFORMATION AVENUE - BOARD 2

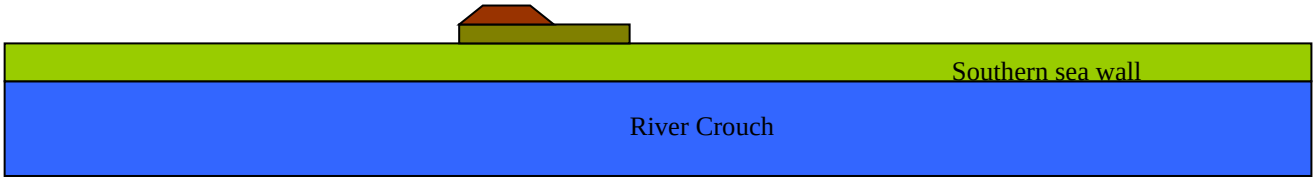
Apparent path of the sun in **WINTER**



At midday in winter (above), the sun is still quite low at its highest point, so it doesn't give us as much heat as in summer, because its coming in low through the atmosphere.
The sun's journey is shorter so the days are shorter.
At midday in summer (below), the sun appears high in the sky, rising in the north east (over Burnham) and setting in the north west (over north Creeksea). The sun is coming directly down through the atmosphere, and so is much warmer.
The sun's journey is longer, so the days are longer. Real darkness lasts just a few hours.



Apparent path of the sun in **SUMMER**

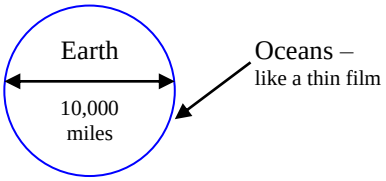


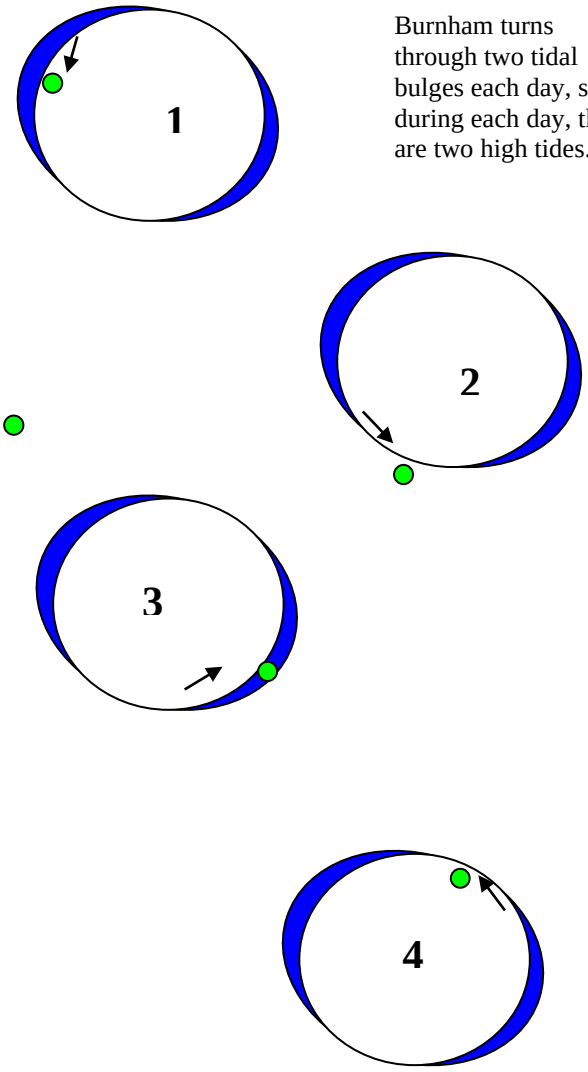
INFORMATION AVENUE - BOARD 3

The Great Tidal Illusion

When you watch the tide coming in, it is not the water moving towards you. Instead it is YOU moving towards the deeper water.

Earth has a circumference of about 24,000 miles. Its diameter about 10,000 miles across. The world's oceans are no more than 5 miles deep, and mostly a lot less than that. So, relatively speaking, the oceans form a very, very thin layer of water around the globe. So thin, in fact, that would be thinner than the blue line in this diagram:





Burnham turns through two tidal bulges each day, so, during each day, there are two high tides.

Because the oceans are so thin, the gravity from the moon and the sun pull it up a few metres, creating a bulge of water, typically about 4 metres high. This is the **Tidal Bulge**.

For reasons explained by advanced physics, the bulge created by the pull of the moon and the sun on one side of Earth is mirrored by a tidal bulge on the opposite side of the Earth. 'High Tide' occurs under the bulges.

As Earth turns each day, the bulge of water stays more or less in the same place, but Earth turns *beneath* it. The **green dot** represents Burnham.

1, Burnham is experiencing **high tide** (The tidal bulges are massively exaggerated in these pictures to make it easy to see)

2. Six hours later, Earth has turned a quarter turn, moving Burnham into the place where the seas are 'stretched thin'. **Low tide**.

3. Six hours on and the Earth has made another quarter turn, and Burnham has moved into the 'mirror bulge', and so is experiencing **high tide** again.

4. And another six hours on finds Burnham experiencing a **low tide** once more.

So, on average, there are **two high tides and two low tides every day**.

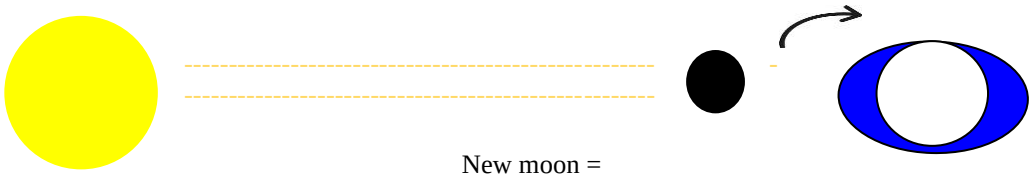
Over each month, the tidal bulge creeps round the earth, tracking the movement of the moon. These changing influences make the high and low tides about half an hour later each day.

Calculating the tides is very complex. You can find out what time the tides are (and what height they'll rise) at the Harbour Master's office on the waterfront in the town. Or you can buy tide tables from local chandlers.

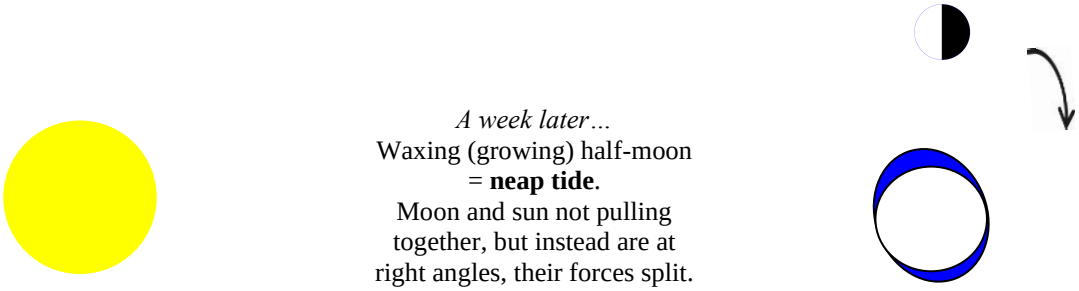
Or go to **burnham.info** and search for Tides.

HOW THE SUN AND THE MOON AFFECT THE TIDES

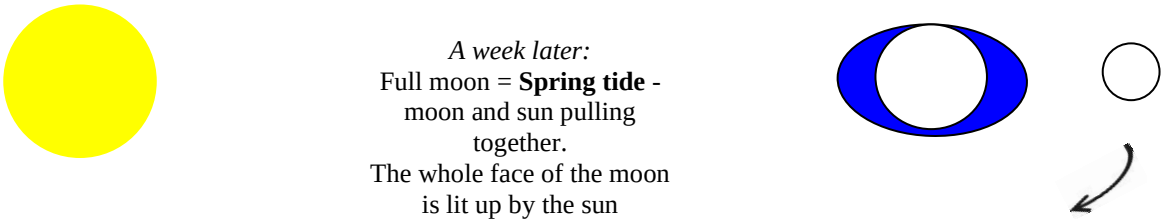
- Spring Tides occur every fortnight.
- So do Neap Tides – every other fortnight.
- See the illustrations below:



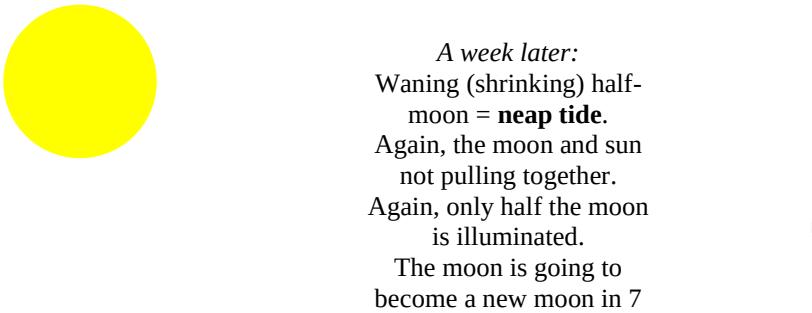
New moon =
Spring tide -
moon and sun are pulling together.
The moon is between us and the sun, and is invisible.



A week later…
Waxing (growing) half-moon = **neap tide**.
Moon and sun not pulling together, but instead are at right angles, their forces split.
Half the moon is visible, when viewed from earth.



A week later:
Full moon = **Spring tide** -
moon and sun pulling together.
The whole face of the moon is lit up by the sun



A week later:
Waning (shrinking) half-moon = **neap tide**.
Again, the moon and sun not pulling together.
Again, only half the moon is illuminated.
The moon is going to become a new moon in 7 days.

- When the moon is in half-shadow, this does *not* mean it has half the pulling effect. The strength of its gravity remains the same.
- It's just that it is not pulling along the same line as the sun is pulling. So the combined effect is weaker, creating neap tides.
- So, if you see the moon in half shadow, expect neap tides.

INFORMATION AVENUE - BOARD 5

SPRING & NEAP TIDES

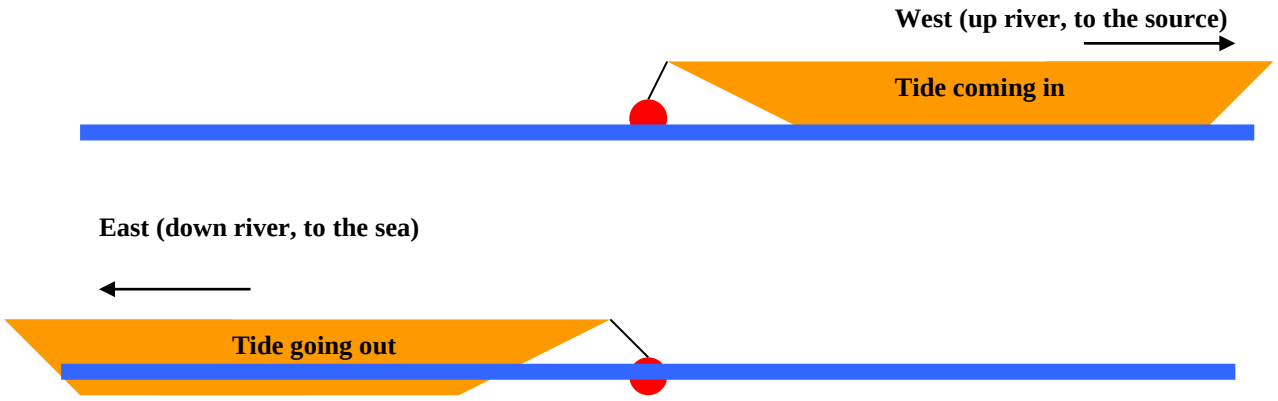
- **In a neap tide**, the water doesn't come in so far, and doesn't go out so far either. It also flows much more slowly, and is safer to swim in.
- **In a spring tide**, the water comes right up the sea wall, and it goes a long way out - often nearly to the end of the floating pontoons that you can see sticking out into the Crouch along the waterfront.
- In certain weather conditions the tide will get almost to the top of the sea wall at high tide and go right out beyond the pontoons at low tide.
- **Spring tides** don't coincide exactly with the full and new moons. Because of the complexity of the orbits, gravitational affects and variations in coastline and seabed, they usually occur a couple of days afterwards. The same is true of neap tides and half-moons. See also *Turning Burnham* and *Motions of the Moon*.

IS IT SAFE TO SWIM IN THE CROUCH?

- The tide moves fast in spring tides- about 3 knots - almost 4 miles an hour.
- This is because a lot of water arrives in the 6 hours between high and low tide.
- It is therefore dangerous to swim on a spring tide.
- If you do find yourself swimming in a spring tide, and you are running out of energy, don't make the mistake that has **drowned many people**. *Don't fight the tide*. Swim with it, slowly, and work your way to the shore.
- For more, go to **Burnham.info** and search for ‘swimming in the Crouch’.

HOW DO YOU KNOW IF THE TIDE IS COMING IN OR GOING OUT?

- It's usually quite easy to tell what the tide is doing in Burnham. Just look at the moored boats. If the sterns (backs) of the boats are facing east, down river, towards Burnham and the sea, then the tide is going **out**. This is because the 'ebbing' (or outgoing) tide has swept the boats behind their mooring buoys.
- Conversely, if the boats' sterns are facing upriver towards Creeksea and the source of the Crouch near Little Burstead, Billericay-way, that means the tide is coming **in**, (or 'flooding').
- Sometimes strong winds make it harder to tell which way the tide is flowing, because the boats turn in the wind. But usually boats on the far (south) side of the river obey the tide rather than the wind, because the water is deeper there, and the tide is stronger. Also, boats moored on the far side of the river tend to have deeper keels, which reach deeper into the tide and so are pushed harder.



INFORMATION AVENUE - BOARD 6

A LITTLE ASTRONOMY

If you look to north on a clear night, and look up, you will see the **Great Bear** constellation, also known as Ursa Major, the Big Dipper, the Plough, and the Saucepan, among other names.

The arrow shows how to line up the two 'pointer' stars (Dubhe & Merak) to find the Pole Star (Polaris), which works like a compass to show you north.

Because the Great Bear appears to rotate around the pole star, it can appear various ways – it can even look like a question mark in the sky.

THE NORTH POLE AXIS

The **North Star** effectively sits right above the north pole. Imagine for a moment, as you look up at the pole star, that is has an actual pole attached to it coming all the way down to the top of the earth at the north pole. (It would be one mother of a pole – some 434 light years long.) Then you may begin to visualise how we are spinning around the axis of that pole.

Look up to the north star and stretch your arms out. Then lean to your right. Your hands are describing the earth's rotation – this motion will help you get a sense of the turning planet and the how the stars appear to move during the night. The sky will move in the direction of your hands.

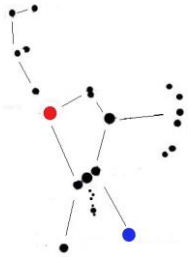
You will notice over the hours that the whole sky appears to be rotating clockwise, with the Great Bear and all the other stars rotating around the north star. Of course, it is the turning Earth that creates this illusion. The sky is not turning – it is the planet that is revolving.

Opposite the Great Bear, you will see a zig-zag-shaped constellation. This is **Cassiopeia's Chair**. Depending on the time of year, it appears as a W or an M or something like a lightning strike. Like all constellations, it rotates around the pole star.

WHERE IS NORTH?

So, the point is, if you are lost at night and need to know which way is north – say, you want to head towards Southminster – then look up, identify the pole star using the Great Bear and just 'follow that star'.

SOME OTHER STAR STUFF TO LOOK FOR



- Another famous constellation is **Orion the Hunter**, which you can see to the south in **mid-winter**. You can make out his bow to the right, and his sword hanging down from his three-star belt. This is in fact the Orion Nebula, a star nursery where stars are being born amid great violence.
- Its upper left shoulder is a Red Giant called **Betelgeuse**, which might go supernova (blow up) at any time. In fact, being 640 light years away, it could have already done it – it will be spectacular when it does. Equally, it might not blow for a million years – in the words of the late astronomy legend, Patrick Moore, 'we just don't know'.
- Orion's right knee is **Rigel**, a blue-white supergiant nearly 900 light years away.
- Below and to Orion's left is his hunting dog, **Sirius**, the Dog Star – the brightest star in the sky. Just 8.6 light years away, Sirius is twice as massive and 25 times brighter than the Sun. When Sirius rises just before a summer sunrise, it heralds the 'dog days' – a hot, lethargic, uncomfortable period that the Ancient Greeks associated with bad luck.

INFORMATION AVENUE - BOARD 7

MOTIONS OF THE MOON

- The moon orbits the earth once a month – in fact, once every 28 days. ‘Moon’ and ‘month’ are related words.
- It goes around the earth in the same direction the earth rotates – towards the east.
- It is travelling at over 2000 mph, but because it is a quarter of a million miles away, it appears to be moving more slowly than the earth is rotating.
- Consequently, the moon rises and sets later than it did the day before.
- In other words, when viewed from Burnham, or anywhere else on earth, it appears to have a net westward motion.

WHEN YOU SEE A CRESCENT MOON IN THE SOUTH WEST

- When you see the crescent moon in the south west near the sunset, that means that the moon was new a day or so ago.
- It will be setting within a few hours – possibly less.
- It indicates a spring tide – the high tide will be very high and, at low tide, very low.
- It also means the moon has just begun its monthly journey around the earth.

WHEN YOU SEE A FULL MOON

- It means it has completed HALF of its monthly journey around the earth.
- It also means it is just coming up to spring tides again.
- For the rest of the month, the moon won’t set but will be up all night – until the next new moon, about 14 days after the full moon.

WHEN YOU SEE A CRESCENT MOON LIKE THIS

- This is a waning moon, and it’s a day or so from disappearing – i.e., becoming a new moon again,
- It has almost completed its 28-day journey around the planet.
- Like the full moon, it will be visible all night.
- Sometimes it appears in the north west – such are the vagaries of the moon’s orbit around the earth.

ASTROLOGY, THE ZODIAC & THE ECLIPTIC

- The Ecliptic is the path that the sun appears to follow through the sky during the day.
- The moon, more or less, follows it too.
- So do the planets, more or less. This is because the sun and planets orbit all pretty much in the same plane – having coalesced from a disc of matter that surrounded the young sun.
- At night and throughout the year, the ecliptic is visibly populated by (at least) 12 constellations of stars, such as Sagittarius, Aquarius, Pisces, etc.
- These are the 12 constellations of the Zodiac, made popular by Astrology. Depending where we are in our orbit determines which constellations we see. If you are up all night, you can usually see at least six of them.
- When Astrologers say things like 'the sun is in Libra' – they mean that if you could see the stars around the sun during the day between September 23rd and October 22nd you would see that it was passing through the constellation of Libra.
- However, things have shifted somewhat since Astrology was invented, and the sun's position is now out by about a constellation…
- You might want to google your own zodiacal constellation and identify it in the night sky.