In 1821 James had been approached by Joseph Sanders to survey a rail line between Liverpool and Manchester, which he carried out at his own expense. The surveyors were Paul Padley, his brother in law, assisted by George Hamilton (qq.v.). Whilst surveying Chat Moss, William slipped into a bog and was saved from drowning in it by George reaching out to him with his surveying staff.

Unfortunately he was imprisoned for debt in August 1823. He owned thousands of pounds, part of which was for the disputed dowry. Joseph Sanders formed the Liverpool and Manchester Railway Company whilst James was in Fleet prison. Although James tried to keep the survey as a bargaining counter, Paul Padley took a copy to Stephenson. James managed to prove that the dowry allegedly owed to his sister was not legally due, but emerged from prison to find his affairs in the hands of receivers. Up to and including his time in prison he was involved in many different railway ventures.

From his early surveys of the Somerset railway in 1799 and the preliminary work on the Liverpool and Manchester in 1802 the importance of rail transport grew to overshadow his other surveying and legal work. After he became chairman of the West Bromwich Coal Masters Association in 1816 he proposed the Birmingham and Wolverampton, the Birmingham and Manchester, and the Birmingham and London railways. He was clearly thinking of a network rather than individual lines. His initial plans for the Stratford and Moreton Railroad in 1820 were entitled 'Plan of the lines of the Central Junction Railway or Tram-road ...' and showed the line extended to London. By 1823 his interests were on a national scale; the Bristol, Salisbury and Southampton Railway, and Bristol, Bath and Bradford Railway would have formed a network ready to couple with the London, Brighton, Portsmouth and Chatham. He took an active part in promoting all of them, even to the extent of publishing a report to illustrate the advantages of the London–Portsmouth route from his prison cell. He had also been involved with the Canterbury and Whitstable, the Truro and St Agnes, the Padstow Bodmin and Fowey, the Algavoar Moor, and the Bishops Stortford, Cambridge and Newmarket railway.

James was destitute when released from prison, his family living with his agent, Mr. Bill, at West Bromwich. He became the clerk to the Stratford and Moreton Tramway but by now he was embroiled in a feud with Stephenson as the board of the Stratford and Moreton railway was being filled with Stephenson's friends, such as John Urpeth Rastrick (q.v.), who engineered the line to completion. James was removed from his post as clerk in April 1826 and he retired to Plas Newyyd Farm, Bodmin, Cornwall.

Here James carried on a legal practice and acted as land agent for the Cornish gentry. His wife, Dinah, and eldest daughter died just before the move. James remarried around 1830 and started to rebuild his life and in 1836 he was once again trying to promote new railways. In February 1837 he returned to West Bromwich to attempt to salvage his property from the receivers. He took a carriage journey back to Bodmin as his wife was giving birth to his last daughter Winfred, but he caught influenza during the rigorous trip. The illness was to prove fatal and he died on 10 March 1837. He was buried at Bodmin church.

N. BILLINGHAM

[Henley in Arden Parish Records, Warwickshire County RO; Estate papers of Earl of Darmouth, Staffordshire County RO; Minutes of the Stratford on Avon Canal Company, 1793–1816, PRO; Minutes of the Stratford and Moreton Tramway Company, 1821–1826, PRO; Kings Bench Record 1823, PRO; *The Two James's and the Two Stephensons* (1861) anonymous pamphlet by E.M.S.P., believed to be James' daughter Elizabeth Tranter Payne; C. Hadfield and J. Norris (1962) *Waterways to Stratford*; C. Hadfield (1969) *The Canals of the West Midlands*, 2nd edn.; G. Biddle (1990) *The Railway Surveyors*]

Publications

1798. *Two plans of London Dock, with some Observations respecting the River*
1820. *Plan of the Central Junction Railway*, copy in *The Two James's and the Two Stephensons*
1823. *Report to illustrate the Advantages of direct inland Communication through Kent, Surrey, Sussex and Hampshire to connect the Metropolis with the Ports of Shoreham, Rochester and Portsmouth*

Works

1806–1816. Southern section of Stratford upon Avon Canal, 13 miles, £143,000
1815–1823. Upper Avon Navigation, restoration, 17 miles, £18,000
1821–1826. Stratford and Moreton Tramway, 16 miles, £40,000

JARDINE, James, FRSE (1776–1858), son of a farmer of the same name, was born at Applegarth, Dumfriesshire on 13 November 1776. After having shown great ability in mathematics at Dumfries Academy, he went to Edinburgh with an introduction from his teacher to John Playfair, professor of mathematics at the university, where he attended classes. Playfair befriended him, obtaining employment for him as a mathematics teacher.

By 1809 Jardine, on Playfair's advice, had begun to practice as a civil engineer and by 1811 had opened an office in Edinburgh. In 1809 he observed water levels in the river Tay with reference to salmon stake nets. He was, according to Professor W. J. M. Rankine, the first to determine—by observations of the tides over a great extent of coast—the mean level of the sea and to show the symmetry of the undisturbed tidal wave above and below that level and the effect of a

James Jardine FRSE

river current in disturbing that symmetry; they were 'discoveries of high importance, both scientific and practical'.

In 1810 on the recommendation of Thomas Telford (q.v.), with whom he was to become closely associated during the next three decades, Jardine accurately determined the levels and produce of springs in the Pentland Hills, near Edinburgh. This work eventually led, in consultation with Telford, to his best known achievement, supplying Edinburgh with a plentiful supply of pure water. This water came from Crawley spring via an iron aqueduct and involved construction of a compensation water reservoir at Glencorse with one of the tallest earth dams of its time—nearly 120 ft. high—and a cut-off trench. In 1825 *The Scotsman* described these works, which had cost about £145,000, to be 'the most extensive, perfect and complete ever executed in modern times'.

From 1819 until 1846 Jardine was engineer to the Edinburgh Water Company, for whom his last major project was the harnessing via Clubbiedean reservoir of the Black Springs at the Bavelaw and Liston-Shiells estates on the North Pentland Hills and the construction of compensation water reservoirs at Threipmuir and Harlaw, near Balerno (1843–1848). Other water supply schemes upon which he is known to have been consulted included Perth (1828), Dumfries (1833), Glasgow (1834), Cobbinshaw reservoir for the Edinburgh & Glasgow Union Canal (*c.* 1818), and Leslie, Fife (1853). He was also employed on several important law cases involving hydraulics relating to mill dams. In 1830 he was consulted on the partial drainage of Loch Leven by straightening the river flowing from it, building new bridges, and he successfully superintended the lowering of the loch by several feet. From 1831 until 1849 he acted as the Commissioner for this project which provided water power to many mills on the river Leven.

Jardine's other work in Edinburgh included road lines and levels, retaining walls and foundations, associated with the architectural projects of William H. Playfair and others, drainage of what remained of the North Loch (1813) and also, to the south, the 'Meadows' and heating the Signet Library. Jardine also had a considerable practice in the improvement of transport communications throughout Scotland. In 1813–1814 he surveyed and estimated the cost of the Annandale Canal project in Dumfriesshire, and the continuation of John Rennie's (q.v.) Union Canal line via the south and east of Edinburgh to Leith Docks. Neither proposal was executed. In 1818 he advised on the proposed deviation of the Union Canal line through Callandar Park, near Falkirk. From 1825 to 1830 he prepared extensive surveys and estimates for a railway between Edinburgh and Glasgow but his proposals, although seriously considered, were not adopted.

In 1826 Jardine was appointed engineer for the Edinburgh & Dalkeith, or 'Innocent' Railway as it was later known, which became operational in 1831 and cost, with the completion of its branches in 1838, about £133,000. At its Edinburgh end under Holyrood Park he built the first public railway tunnel in Scotland and a steam-engine operated inclined plane 1,160 yd. long. Near Dalkeith he built what is now his finest surviving bridge, Glenesk Bridge, to carry the railway over the river North Esk (*c.* 1830, conserved 1993). The 570-yd. tunnel and a now unique cast-iron beam bridge over the Braid Burn near Duddingston (1831) were conserved by Lothian Regional Council in the 1980s. Although operated by horse traction, the railway was commercially successful both as a mineral and passenger railway. For a number of years prior to its adaptation for steam locomotion in 1846–1847 it carried more passengers per mile than the Liverpool and Manchester Railway. In 1827 Jardine also became engineer for the Ardrossan and Johnstone Railway which, although underfunded, was opened from Ardrossan to Kilwinning in 1831. He also conducted road surveys, for example in Dumfriesshire in 1829 and on the 'Great North Road' to Perth from Milnathort to Glenfarg (1825–1832), probably at Telford's request.

Following the success of steam locomotion on the Liverpool & Manchester Railway, horse-traction became rapidly outdated and Jardine seems to have had little further involvement with railways, although he did survey the Nith valley line in Dumfriesshire in 1835. His river and maritime projects included Saltcoats Harbour (1811), river Tweed (1813, 1817), river Tay (1818–1833), river

Forth ferries, Earl Grey and King William IV docks at Dundee in consultation with Telford (1829–1832), Perth (1831), Leith (1833–1835) and Eyemouth (1837) harbours and an evaluation of metal lighthouse proposals for Skerryvore reef (1837).

Jardine was also a leading bridge engineer in Scotland. At Telford's request in 1821 he furnished calculations of chain strengths at different degrees of curvature for Menai suspension bridge. In addition to his railway bridges he is known to have built masonry bridges on routes in which Telford had an interest: at Threave, Kirkcudbrightshire (1825), Almond, near Perth (1827), and at and south of Dalkeith on the Edinburgh–Jedburgh–Newcastle Road (1827–1838). Jardine's unexecuted masonry bridge projects included a five-span design for Dean Bridge, Edinburgh (1828) and a 160 ft. span at Coulternose (river Findhorn). He also erected a timber bridge over the river Tweed at Innerleithen in 1830 and a light iron truss bridge over the river Whitadder at Hutton Mill, Berwickshire, in 1837. Jardine's masonry bridge designs were influenced by Telford's practice but were more refined in some respects. He adopted notably small arch ring depths which reduced towards the crown, low-rise elliptical arches and longitudinal walls within hollow spandrels, all measures that economised on materials and reduced weight on the foundations. Rankine assessed Jardine's work as 'all models of skilful design and solid construction' and his masonry 'worthy of the study of every engineer'.

Jardine had a national reputation as a scientific engineer. He played an important part in determining the proportions of the old and diverse Scottish weights and measures to the imperial standards, conducting his enquiries 'with extreme precision'. In 1811 he determined the length of the ell as 37.0598 in. at 62°F. From 1812 to 1814 he measured water temperatures at different depths in Lochs Lomond, Katrine and the river Tay, work which was still considered of value when it was first published in 1871. He was elected a Fellow of the Royal Society of Edinburgh in 1812, the Geological Society in 1816, and to membership of the Institution of Civil Engineers and the Society of Civil Engineers in 1820 and 1827 respectively. He was also a director of the Edinburgh Astronomical Institution and its Astronomer from 1815 until 1825.

From 1826 Jardine operated his practice from his house at 18 Queen Street, Edinburgh, where he died on 20 June 1858. Although a bachelor, he had a daughter, Ann, by Margaret McGee. Rankine commented from personal knowledge, presumably having first met him when Rankine's father was manager of the Edinburgh & Dalkeith Railway, that although Jardine's manner 'was somewhat eccentric and cynical, he secured the warm regards of his intimate friends amongst whom were many of the highest eminence in science'.

R. A. PAXTON

[National Archives of Scotland (SRO), Register House Plans and E&DR minute books; W. J. M. Rankine, *Imperial Dictionary of Universal Biography*, **XII**; *The Scotsman*, Suppl. 252, 26 June 1858; F. Whishaw (1842) *The Railways of Great Britain* ...; J. Colston (1890) *The Edinburgh and District Water Supply*; R. A. Paxton (1968) *Three Letters from Thos. Telford with Introduction and Notes*; Skempton; R. W. Jardine (1992–1993) James Jardine and the Edinburgh Water Company, *Trans Newcomen Soc*, **64**, 121–130; R. A. Paxton (1993) *Edinburgh & Dalkeith Railway—Glenesk Bridge, Dalkeith*; Private information]

Publications

1830. *Report ... for a Survey and Plan of a Railway from Edinburgh and Leith to Glasgow*

1830. *Dundee Harbour, Report respecting the extension of the Docks*

Main works

1810–1846. Edinburgh water supply, £145,000 (to 1825)

1825–1838. Edinburgh & Dalkeith Railway, £133,000

1829–1832. Dundee Harbour

1831–1849. River Leven improvement

JEANS, Thomas (fl. 1829–1836), of 14 Manchester Buildings, Fleet Street, London, was elected an Associate of the Institution of Civil Engineers on 24 February 1829; at that time he was a pupil of Thomas Rhodes (q.v.). He may have been related to Thomas Jeans (*c.* 1775–1866) who, as architect to the Barrack Department of the War Office, had designed barracks during the Napoleonic Wars. An FSA, he was a founder member of the Architects' and Antiquaries' Club.

MIKE CHRIMES

[ICE membership records; Colvin (3)]

JEBB, David (fl. 1766–1788), canal engineer, is reported as being the engineer in charge of the Upper Boyne Navigation in the 1760s. He appears to have had a personal interest in the work as in 1766 he had completed a large mill at Slane. Under his direction a guard lock was built above Slane Bridge in 1785 at a cost of nearly £1,800.

In 1787, when the Commissioners of Inland Navigation were dissolved, local commissioners were appointed to take over the navigation and Jebb was retained as engineer, treasurer and secretary. The following year, he prepared a detailed report to the commissioners with estimates of the repairs to the navigation from Slane to Stackallan totalling £4764 8s and also made specific recommendations for work on a number of the locks on the navigation, most of which were eventually carried out. He was later entrusted with the duties of toll collector and paymaster of the lock-keepers.

Richard Evans (q.v.) took over as Chief Engineer on the navigation in about 1790.

RON COX